Part 1

Case Studies of Valuation Errors in Corporate Finance and Project Finance

Chapter 1

Overview of Analytical Mistakes in Investment Analysis and Valuation

Introduction to Debt and Equity Valuation Errors when Making Investments

Making investments in capital intensive industries such as electricity generation, real estate, telecommunications, mining, transportation, oil production, agribusiness and infrastructure require business managers to bet a lot of money on uncertain economic variables far into the future. Dramatic mistakes have occurred when assessing value in these and other capital intensive sectors because investors, bankers, managers, rating agencies, consultants and policy makers have used flawed economic and financial analysis. Valuation errors include incorrectly assessing future price trends, demand growth, plant performance, operating costs and capital costs that drive the value of investments. Poor investment decisions have also been made by incorrectly interpreting and applying benchmarks used in practice by various financial professionals. Conceptual shortcomings are made when project finance investors interpret the internal rate of return (“IRR”) ; by bankers inappropriately using various financial ratios in credit analysis; by investment analysts not considering the true economic drivers that underlie valuation multiples such as the price to earnings ratio and the price to book ratio; by investment bankers using the flawed CAPM in attempting to estimate cost of capital; by consultants making artistic presentations with time series analysis that do not really reflect underlying economics; by investment advisors using the formulas that do not correctly measure terminal value; and by executives believing that fancy models such as real options can create somehow create economic profit.

The general idea of this book is that practical valuation techniques and improved investment analysis can be learned from studying where valuation practice has failed and understanding where the underlying theory is just plain wrong. A set of flawed financial analyses that provides very good valuation lessons involved problems in forecasting real estate prices and risk analysis

associated with U.S. mortgage loans that lead to the dramatic worldwide financial crisis of 2008. The housing crisis was of course not the first or the only debacle driven by faulty valuation analysis and many misapplications of financial and economic occurred since the valuation problems that drove the global financial crisis. For instance, in a short period after electricity deregulation was enacted by United States policymakers during the 1990's, the California electricity market was in turmoil; oil and natural gas prices quintupled; the darling of the industry, Enron Corporation, became the largest bankruptcy in United States history; and merchant power plants around the world lost more than $100 billion in market capitalization. This crisis came on the heels of the famous dotcom bubble in which massive over-investment in telecommunication companies and high tech companies resulted in dramatic loan defaults as well as declines in equity value. More recently, many solar manufacturing companies could not survive after realizing very high valuations. Shale gas and oil which apparently saved the U.S. economy also involved errors in evaluating capital expenditures relative to potential cash flow. Case studies of just where valuation analysis have gone wrong and how to avoid similar problems in the future is the foundation of the book.

Accepting some level of uncertainty is a natural part of just about any valuation process. Bankruptcies as well as dramatic changes in value do not necessarily imply bad decisions given available information at the time investment decisions were made. Some investments that went bad to be sure could have turned out to be very successful. The general idea of this book is not to suggest dramatic changes in valuation that deviated from initial expectations can be avoided, but it is rather to identify where faulty analysis and application of use of defective financial theories have resulted in massive losses or gains for debt and equity investors. Valuation errors that have resulted in inappropriate investments that are addressed in the book have not only had devastating implications for investors, they often have had devastating effects for the overall economic vitality of a region.

Underneath the poorly analyzed investment decisions were problems in valuation analyses involving errors in analyzing behavior of prices and/or underestimating the inherent risks of investments and/or believing in seemingly sophisticated analyses without independent verification. Through evaluating case studies of failed investments and then working through the theoretical flaws in many financial analysis techniques, this book confronts standard valuation techniques taught in business schools and applied in many analyses. The flawed analyses include subjects such as using beta to measure risk, interpretation and derivation of valuation multiples from the value driver formula, inappropriate use of historic financial ratios in credit analysis, relying on uneconomic contracts that are supposed to mitigate risk, believing that businesses can be translated into mathematical formulas, ______which provide very little guidance on how to

avoid these and other business failures and it offers practical alternatives that can lead to more sensible assessment of investments.

Summary of the Book

This book deals with a myriad of errors that occur in the debt and equity valuation of corporate finance and project finance investments. The ability to value assets and to assess risk of investments is vital for business managers who make decisions about borrowing or lending money, who invest in new projects, who acquire or sell companies, who sign contracts or who dispose assets. Without doubt, valuation and risk assessment are surely the two most important skills for any finance professional to master. The good news is that when gauging the value of anything -- from factories, to debt or equity investments, to marriage contracts -- the ultimate analytical problem can be boiled down to only two things. The first is forecasting your future net benefits, (measured in finance by prospective cash flows), and the second is assessing the risk associated with your projections. The bad news is that even though these two things are all that is at the root of any valuation problem and indeed are at the bottom of any subject in the study of finance, application of finance theory to real world investment decisions has been frustrating at best and just plain irrelevant at worst. To present valuation techniques that can improve real world investment analysis, subsequent chapters will delve into a variety of practical ideas and analytical models that project cash flows and assess risk.

Topics to be covered in this text include explanation of how financial analysis techniques are misapplied or how the underlying theory is just plain wrong. Many of the topics covered reveal that academic finance theory is all but useless and that a fundamental re-thinking of classic valuation techniques is necessary. Problems with the way financial analysis is applied is illustrated through review of selected case studies where financial analysis failed. The book in organized by first review the case studies and then working through mathematical and conceptual problems with many financial analysis practices that are all but taken for granted in project and corporate finance analysis. Practical and conceptual flaws are divided into 5 parts as follows.

Part 1 – Case Studies of Valuation Mistakes in Corporate Finance and Project Finance

Part 1 includes a survey of a few selected valuation calamities in project and corporate finance where application of valuation analysis failed miserably. The errors were made by bankers, investors, consultants and other financial analysts who either did not apply basic economic principles in making forecasts or who used financial principles that do not really work in practice. Many of the cases are derived from articles published by the Harvard Business School or the Stanford Graduate School of Business that are routinely used in teaching finance. Rather than applauding management as is done in business school classes, the case studies demonstrate many fundamental flaws in the way investment analysis is made. Various cases demonstrate how attempts to generate high IRR's resulted in taking political risk; how investment bankers trust rate of return forecast that are implausible; how valuations made by very well paid professionals using multiples make no sense; how contracts developed by graduates from the top universities cannot be sustained; how valuations from the CAPM are useless; how use of stochastic mathematical equations and real options that are popular with consultants and academics fail in practice; how valuation analyses that seem to be sophisticated fail because do not begin with fundamental principles of marginal cost fail; and how dangerous it is to believe independent experts who use fancy business terms that are in fact meaningless.

Although some rather complicated models are presented and a bit of finance theory is discussed, the stories of valuation mistakes emphasize that better human judgment and intelligence with respect to very basic economic principles rather than increased sophistication in analytical techniques is the primary factor that could have avoided most of the valuation misfortunes. The different valuation debacles confirm an obvious but often neglected point that all of the sophisticated financial models, elaborate mathematical representations of risk, application of intricate finance theory and other analytical tools are irrelevant without being supplemented by a healthy dose of wisdom and business sense. Many learned the hard way that risks associated with lending money to a waitress in who puts no money down on a $500,000 house cannot be gauged by running thousands of simulations in a Monte Carlo analysis by a credit analyst at Standard and Poor's on the 50th floor of an office building in Manhattan.

The case studies include project finance and corporate finance investments where a series of conceptual analytical flaws that, with hindsight, should have avoided an investment. Some of the case studies happened a long time ago and others are more current. Many of the studies use Harvard Business School write-ups where the original case was written to demonstrate the efficacy of business executives. The case studies have been selected because they demonstrate flaws in valuation that are discussed later-on in the book.

Before describing problems with IRR interpretation, use of multiples in valuation, cost of capital and other technical subjects, case studies that involve faulty analytical techniques that seem to recur are discussed.

Part 2 – Problems with Financial Theory and Attempting to Measure Cost of Capital with Flawed Capital Asset Pricing Model

The second part of the book moves from valuation mistakes in practice using case studies to failings in the theory of finance. A lot of finance theory deals with attempting to put a number on risk using statistical analysis of market data. Measuring the cost of capital which measures the minimum level of return that requires some person or organization to take risk is a very difficult task. Unfortunately when making valuations from using many of the common techniques such as the discounted cash flow process, it cannot be avoided. The chapter begins by reviewing traditional cost of capital analysis using the Capital Asset Pricing Model (CAPM). Initial chapters in Part 3 of the book demonstrate that the typical CAPM techniques taught in business schools fail when it comes to most practical investment decisions. Next, an alternative way to translate cash flow risk into value is described which uses debt capacity to evaluate equity returns. The information source for the debt capacity analysis is financial criteria from bankers and credit rating agencies in asset and equity valuation. Because bankers and credit rating analysts are people who supposedly measure risk and to quantify the overall risk of an investment, valuation techniques derived from debt capacity should be superior to theoretical analyses using the capital asset pricing model which is founded on un-measurable parameters and is subject to bias. That is as long as bankers are doing their job.

In fact, bankers and credit rating agencies have not had a stellar record in assessing risk. Because of this, a third method of translating cash flow into value is introduced that uses synthetic debt capacity measurement and time series analysis. This method simulates the theoretical debt capacity of a project through evaluating the probability of default and loss given default derived from time series parameters and Monte Carlo simulation. Once the theoretical debt capacity is established, the value of an investment can be derived through establishing a minimum rate of return as with the method that uses benchmark ratios from bankers and credit rating agencies.

The discussion covers various different investment valuation techniques that compute the value of an investment given the riskiness of cash flows.

Different approaches that apply the theory of finance, that use financial market data, and that extend option pricing theory to measure risk are presented.

Part 3 – Misuse of Financial Ratio Benchmarks: Problems in Interpreting IRR, Credit Spreads, Earning Multiples, Market to Book Multiples, Return on Investment, Debt to Cash Flow, Debt Service or Interest Coverage Ratios

Part 3 of the book turns to analysis of commonly applied practices in terms of interpreting credit spreads, IRR's, return on investment, credit ratios, multiples and other financial statistics used to assess investment value and credit quality. This part of the book begins by comparing valuation analysis that uses the CAPM and discounted cash flow with analysis that is derived from debt capacity and equity IRR benchmarks. Subsequent chapters deal with how and why benchmarks can fail in measuring the real value of an investment. In project finance, financial ratios used include the IRR, the DSCR and a couple of their variations. The ratios are attractive because the entire information about a project can seemingly be summarized in a single number. Once the mathematics of the IRR are understood it becomes apparent that interpretation of the ratio is a whole lot more nuanced. When turning to corporate valuation involves similar flaws become apparent in applying multiples such as the price to earnings (P/E) ratio and the enterprise value to the EBITDA (EV/EBITDA) ratio as well as detailed issues associated with the discounted cash flow model. This chapter is not like a typical textbook treatment of discounted cash flow analysis that describes how to compute free cash flow and then add the terminal value and discount the cash flow at the WACC. Instead, the chapter explains theoretical and simple mathematical flaws in the way simple weighting of debt and equity is computed in the WACC; it describes flaws in how betas are un-levered and then re-levered and it explains why the cost of equity does not necessarily increase for highly leveraged companies due to call option characteristics of equity capital. The chapter explains how to establish drivers that explain why a P/E ratio, an EV/EBITDA ratio or a market to book ratio should be at a given level. Finally the chapter bridges the very wide gap between theory and practice in applying the discounted cash flow model. Real world problems addressed include determining stable relationships between depreciation and capital expenditures, treatment of deferred taxes and long-run estimates of changes in deferred taxes, consistency between

working capital changes and growth rates, use of multiples in computing terminal values and other issues.

Part 4 – Measuring Production Cost as the Basis for Long-term Assumptions in Financial Analysis

The most important component of any valuation analysis is forecasting the trends and variability in economic drivers of cash flow including prices, costs of new equipment and demand growth. The final part of the book describes practical forecasting issues involved in coming up with sensible predictions of these cash flow drivers. Marginal cost is introduced as the basis for gauging the future trends in prices. Marginal cost is not described in terms of esoteric economic theory, but rather in practical ways that can be used as a basis for key drivers in cash flow forecasts. Even though marginal cost may not equal the market clearing price, analysis of marginal cost and understanding of marginal cost concepts provides the foundation for evaluation of price trends and volatility. Subjects covered in this part of the book include the definition of marginal cost, translation of capital investment costs into periodic marginal cost, and derivation of equilibrium long-run marginal cost with multiple technologies. Pricing theory is introduced by through defining various components of short-run and long-run marginal cost in different markets. Analysis of carrying charge rates demonstrates the manner in which cost of capital, inflation expectations and technology risk affects measurement of long-run marginal cost. In the final part of the chapter, a model of long-run marginal cost is presented to illustrate how one can develop reasonably simple methods to assess price levels that are sustainable over the life of an investment. This type of model of equilibrium long-run prices can be used as a benchmark to assess the reasonableness of forward price forecasts developed with far more complex forward pricing models.

The final part of the chapter describes analytical models that are derived from supply and demand analysis. The chapter applies time series concepts to incorporate volatility and parameters into pricing models. Through combining marginal cost concepts with time series analysis, a probability distribution of prices in different market can be simulated for use in debt capacity and option analysis. For example, the volatility can be computed assuming different levels of surplus or deficit capacity and differing capacity mixes through applying time series models of demand, fuel prices, maintenance outages and other factors.

Part 5 – Attempting to Represent a Business as a Stochastic Mathematical Equation and Finding Value in Real Options

The final part of the book addresses risk analysis in valuation by first presenting a variety of practical ways to directly measure risk using traditional sensitivity analysis, scenario analysis, break-even analysis and tornado diagrams. After describing judgmental approaches to risk analysis requiring judgment, the remainder of the chapter focuses on use of time series models as the basis for mathematical quantification of risk – equations developed from statistical parameters such as volatility, mean reversion, price boundaries, industry productivity trends, correlation between variables and jump processes. Development of time series equations as part of the valuation process can appear very attractive because the equations can be used to compute statistics such as value at risk, probability distribution of equity returns and minimum required credit spreads. The discussion notes that while time series models can become addictive in seeming to provide answers to many financial problems such as deriving the probability of achieving returns for assets with different risk characteristics, the mathematical techniques can also be useless if statistics are used without explicitly considering the economic fundamentals that underlie the mathematical equations. Because of problems with application of historic data in construction of time series model parameters, the chapter explains how to construct time series equations using economic theory together with business judgment that allows for dramatic deviations between historic statistical data and prospective distributions.

Chapter seven considers the question of whether option pricing models can realistically be applied to real world capital investment and budgeting decisions. This is not the perfunctory option modelling chapter that seems to be part of any finance text these days. In working through the question of whether option models are really useful, emphasis is placed on practical issues involving the lack of the ability to hedge, mean reversion in cash flow, undefined exercise prices and required management action. These factors create a large gap between plugging in option pricing formulas and applying option theory in a practical manner to measure the value of real investments. The practical issues are illustrated using real options to delay development of an investment, cancel construction of a plant, cease operation, mothball and retire a plant by using different volatility, mean reversion, price boundary and correlation parameters. Monte Carlo analysis that accounts for the mean reversion and the specific operation of plants are compared to option models such as the Black-Scholes equation. At the end of the chapter, option concepts are applied to measurement of the value associated with a

company being the "provider of last resort" where long-term capacity contracts exist along-side customer options to switch suppliers when market prices fall.

Chapter 2

Overview of Case Studies Used to Demonstrate Characteristics of Mistakes Made in Financial Analysis

Financial Theory, Financial Practice and the Global Financial Crisis

Much of this book explains somewhat technical approaches to mistakes in valuation through applying a combination of economic theory, mathematics and financial principles. While the understanding of any discipline requires knowledge of underlying technical and theoretical principles, when it comes to studying valuation, learning from past mistakes may be even more important. The idea behind presenting case histories of valuation mistakes before working through technical details of analytical models is both to introduce selected valuation topics is also to prompt thinking about the underlying valuation theory. The case histories included in the chapters contain analysis that generally resulted in bad investment decisions that caused equity and/or debt investors to lose a lot of money although in some cases it was consumers who were the losers.

The chaotic period in the financial markets that began in the summer of 2008 referred to as the global financial crisis is used to introduce case studies and a number of common valuation mistakes. The financial crisis experience could have been used by academics and practitioners as an indication that they need to go back to harbor and take a hard look at everything from efficient market theories to models such as the CAPM to the basic question of what constitutes risk to how financial models are constructed. It was not. A number of theories, models, and financial strategies routinely used in valuation have proven to be erroneous or, more often and more important, simply irrelevant in explaining dramatic volatility of asset values. Just about all of the valuation errors that will be discussed in other case studies were also part of the lead-up to the financial crisis.

Many books, films, articles and YouTube videos have attempted to explain what happened in the financial crisis and the discussion below is in no way intended to be some sort of definitive treatment. The idea here is not to delve into details of valuing structured investments, discuss systematic risk or comment on credit default swaps that were famous in the crisis. Instead, the review takes a step back and points out analogies of valuation errors that were made in the housing crisis to flaws that seem to recur in valuing other project finance and corporate investments. Other case studies discussed in subsequent chapters are mentions in the description of the valuation errors. Some of the analysis mistakes made in the financial crisis that are also present in many of the other valuation failures described in subsequent chapters include:

- Using comparative benchmarks from relative valuation to justify the valuation that does not make sense.
- Not accounting for potential surplus capacity when making cash flow forecasts in capital intensive industries that can lead to surplus capacity and price volatility.
- Assuming value can be created from continually earning high returns in cases were monopoly power does not exist.
- Credit analysis that extrapolates from the wrong historic data in evaluating repayment probability
- Failure of fully thought-out downside scenario analysis in evaluating risks associated with contracts
- Not using simple analytical checks to avoid financial jargon when evaluating investments
- Believing that new-fangled financial products can change the fundamental relationship between risk and return
- Applying mathematical analysis to simulate risk when variables do not follow conventional statistical patterns
- Over-reliance on the opinions of experts who have no vested interest in the investment.

Using Relative Valuation to Justify High Valuations that are Not Rational

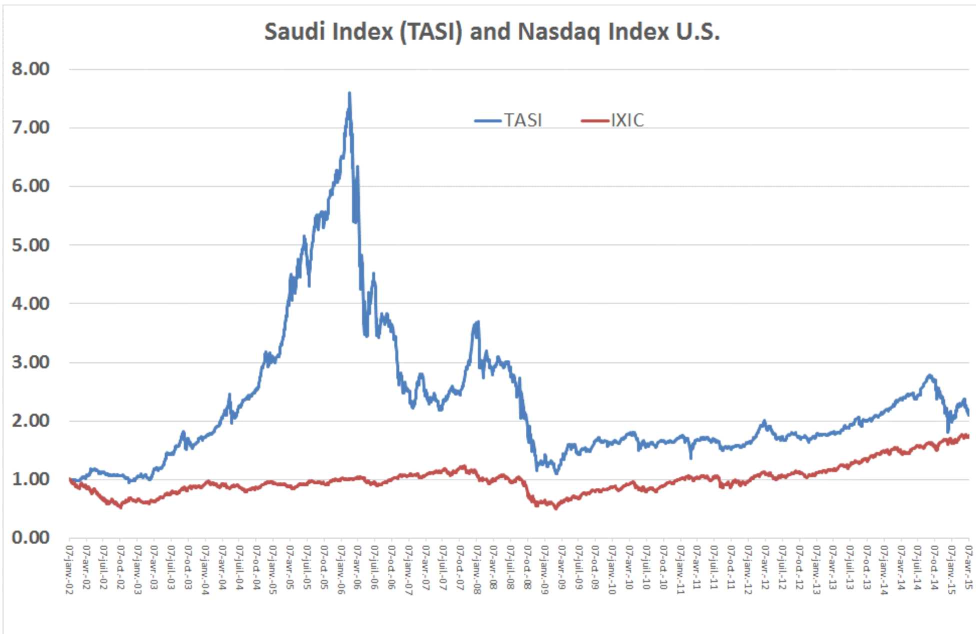
The fundamental problem underneath the housing crisis that subsequently was the major cause of the global financial crisis was valuation of real estate and

more specifically the bursting of a bubble in housing values in the U.S. The first and perhaps the most surprising error made by so many analysts, investors and bankers in the mortgage crisis was the implicit or explicit assumption that values of homes and other real estate would continue to increase at the same time supply was increasing quickly relative to demand. With the benefit of hindsight, this was not rational from a very basic economic perspective. Valuations that result in price bubbles and do not make sense (again, with hindsight) are often the result of making some kind of benchmark comparison rather than performing independent analysis of the economics of the investment. Many valuation problems discussed in later chapters (Petrozuata, Kitty Hawk, and Constellation Energy) arise in part from using inappropriate benchmark comparisons of financial ratios, whether the ratios being compared are P/E ratios, DSCR indicators, political risk premia, or the price of similar houses. The danger arises when the underlying economic implications of these financial indicators is not recognized and where one transaction is gauged relative to another one using a financial ratio benchmark without considering underlying economic fundamentals.

After the dot com collapse and the global financial crisis it has become fashionable to discuss price bubbles and prognosticate about the next bubble that may burst. As with many topics that are discussed in the financial press, the actual definition of a bubble doesn't seem to matter much to experts on the television whose main objective is to sound smart, speak fast and invent new terms. For purposes of the discussion here, a price bubble is defined to occur when the price of something clearly exceeds its inherent value. In the case of a stock, the inherent value is the discounted future value of dividends and earnings. For a house, the inherent value can be defined by the cost of land, material and labor for building a new house. True believers in efficient markets (who have often spent time at the University of Chicago) maintain that there is no such thing as a price bubble or irrational prices and that price increases or declines that some may label as a bubble are the result of some kind of changed expectations. The valuation lesson from the financial crisis and in many of the other cases is that some kind of independent analysis using economic fundamentals is important and the values are not always rational.

One way price bubbles can be sustained is when valuations are explained by comparison with other assets that also have inflated values. Bubbles can occur when people see prices increasing and they do not want the empty feeling of missing out on making money. In using relative valuation and comparable benchmarks to justify prices, new metrics are often invented that cannot be verified from analysis of historic data. A bubble occurred in for Saudi Arabian stocks before it crashed in 2006 that made the dot com bubble in the U.S. seem mild. This bubble in Saudi stock prices is illustrated by comparing the index of

Saudi stocks to the NASDAQ index in Figure 2.1.[1] When prices were on their upward trajectory in Saudi Arabia, valuation benchmarks measured by P/E and EV/EBITDA ratios reached extremely high levels that could not possibly be explained by cash flow and earnings fundamentals. People just kept buying stocks because they believed in things like momentum and in stories told to them that the Saudi market was different from other markets because of things like limitations on foreign investment. There were many sad histories of school teachers, doctors and others selling their houses in order to buy stocks when they were on the way up, only to lose everything in a few months.

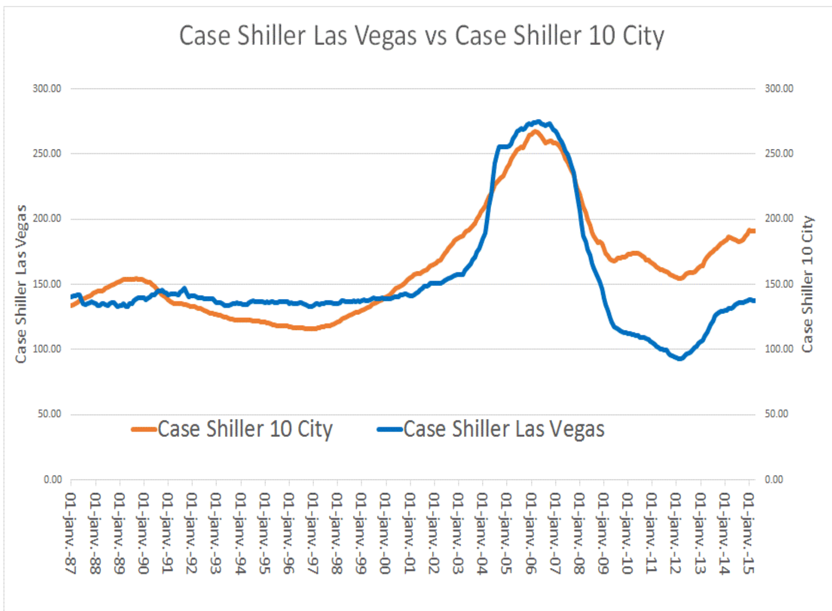


In the context of housing prices and the global financial crisis, investors and lenders did not look at the economic fundamentals driven by what it really cost to build a new home. Instead, they came up with esoteric theories associated with the demand for housing and concocted similar explanations as with the Saudi market of why things are really different this time. Worse, the housing price inflation was somehow attributed to financing and the high demand for mortgages arising from collateralized mortgage obligations. Ideas that housing price increases and potential bursting of the bubble would be isolated to one regional area and risks of housing price reductions could somehow be diversified were just as silly. Nobel Prize laureate Robert Schiller explains valuations during bubbles by beliefs of investors that some kind of undefined smart minds must know what is really happening: People give “increasing credibility to stories … that appear to justify

[1] The source of this data is an analysis of Googlefinance. Methods of downloading the data and creating the graph can be found at www.edbodmer.com/

the belief that the boom will continue. People think the world [that results in price movements] is led by independent minds who invariability act with great intelligence."[2] Similar phenomena of valuations that did correspond to underlying valuations occurred in the Iridium telecom case and the peaking plant valuation case discussed in Chapters __ and ___.

Price bubbles in Las Vegas and U.S. real estate markets before and after 2008 are shown in Figure 2.2[3]. The prices displayed in Figure 2.2 are adjusted for inflation. A fundamental notion of just about any market without monopoly power, is prices have some relation with the cost marginal cost of production, or in the case of residential real-estate, the cost of building a new home. The idea that prices in 2004-2007 had anything to do with the cost of building new houses or other economic principals associated with production cost seemed not to matter anymore.



Trends in prices shown in the Figure 2.2 demonstrate that real prices of homes did not keep increasing or remain at the high levels experienced before 2006. With hindsight, price declines that began in 2007 should have been expected as they have simply reverted back to long-run equilibrium levels which have been quite flat in inflation adjusted terms. Both surplus capacity in the

[2] Shiller
[3] This and other economic time series are downloaded from the St. Louis Federal Reserve Bank website. Descriptions of how to make flexible graphs and download automatically are available on the website www.edbodmer.com

market and diminishing demand for new homes after the market was saturated meant that declining house prices should have at minimum been considered a reasonable possibility in any valuation analysis. The decline in house prices after 2007 meant that that they were simply following a cyclical pattern and reverting to their long-run marginal cost. This lesson certainly does not only apply to real estate and was present in the AES Drax case discussed in Chapter ___ as well as the Eurotunnel case discussed in Chapter ___.

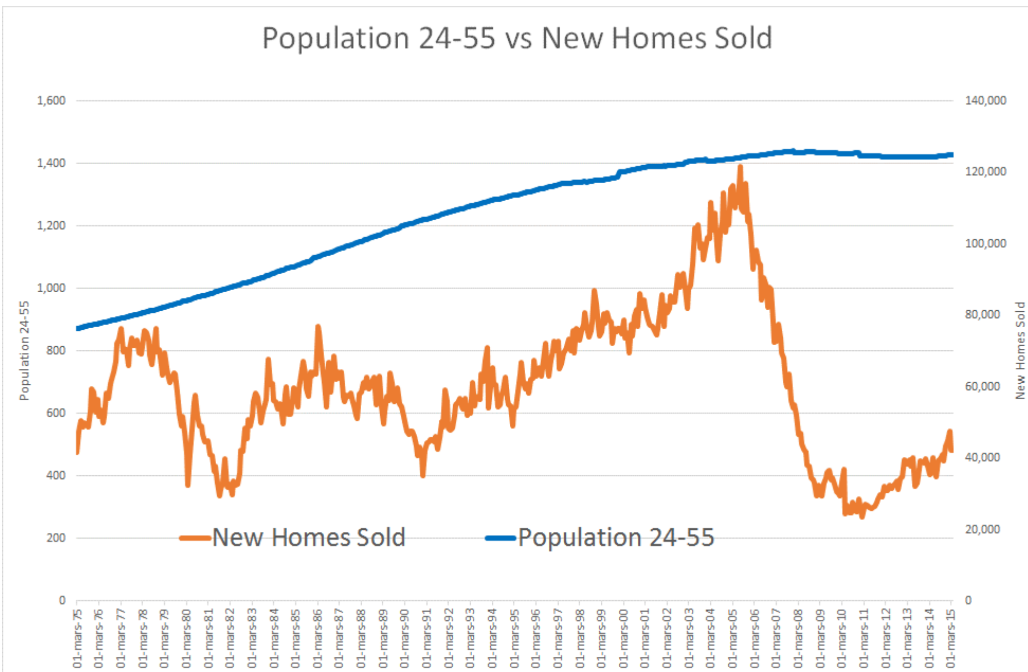
A potential reason that prices kept on increasing is the way appraisers would value individual homes. Valuation of a particular home would be derived from a sample of similar transactions in a region in an analogous manner to the way stocks are often valued by using a sample of P/E ratios. But in creating a comparable analysis of similar transactions, homes that had a relatively low value would often be left out of the comparative sample because of some supposedly non-comparable criteria (if the appraiser did not make this kind of adjustment, other appraisers would be hired). The valuation of a particular home would then be pushed up, meaning larger loans could be obtained and overall prices would rise. This is like selectively limiting samples when making comparisons of the P/E ratio or the EV/EBITDA ratio. Over the tenure of the increase in house prices shown in Figure 2.2, the cost inputs to housing -- building materials such as lumber and cement; the cost of labor; the cost of capital and even the cost of land that drive the change in the marginal cost of housing -- were relatively stable meaning that the valuations could not be explained by the most basic of economic principles. The implication is that when any kind of valuation benchmark is used, the underlying economic drivers of that benchmark must be understood.

Not Accounting for Cash Flow Volatility from Potential Surplus Capacity and Industry Demand

Valuation involves implicitly or explicitly forecasting future cash flows and attributing risk to those cash flows. Making projections of future prices and understanding the potential volatility in prices is more often than not central to the valuation process. When looking forward, the potential for large swings in price occurs when industry capacity increases faster than demand. The possibility of large price swings is more pronounced when investments in the industry are capital intensive. In economic parlance, prices can very suddenly fall from levels that are above long-run marginal cost all the way down to short-run marginal cost. For capital intensive industries like shipping, real estate, oil production, airlines,

telecommunication and electricity, this matters a lot because the difference between long-run marginal cost and short-term marginal cost is large.

At the height of the housing boom, new homes were being constructed at a record pace and the surplus capacity of residential homes should have been clear to anybody who simply drove around sprawling suburban areas of American cities. Just by looking at all of the new homes and wondering who was moving there, questions should have been raised about a potential crash in home values as a result of the surplus capacity. The increase in supply of homes relative to the demand for homes (expressed in terms of population) is demonstrated on Figure 2.3. The graph shows that new homes were being built at a record pace for a long time period. Relative to stable population of home buying age, the graph demonstrates that surplus capacity was increasing[4].

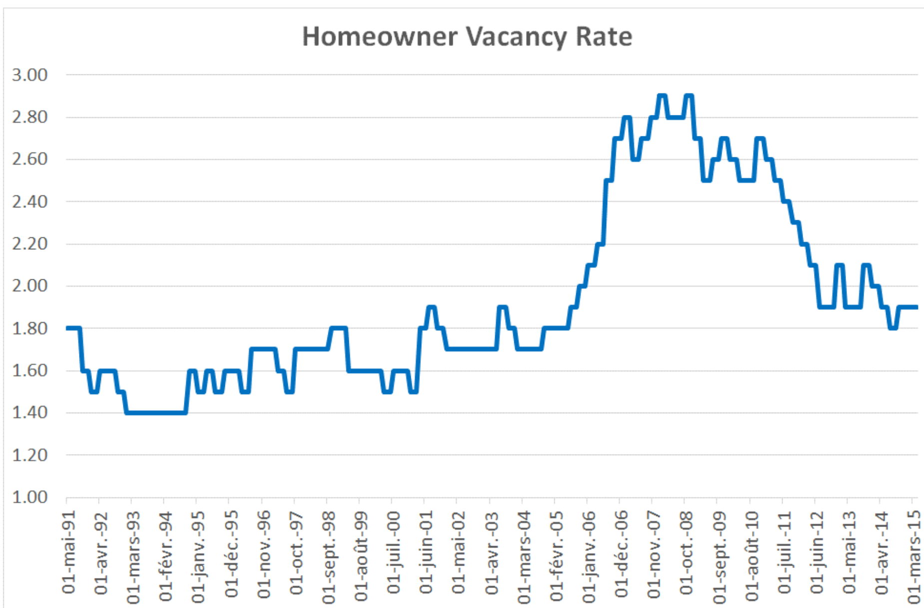


Despite the surplus capacity illustrated in Figure 2.3, risks of downward volatility in prices were not considered even by large sophisticated institutions. The way in which fundamental economics of surplus capacity was ignored is documented by Michael Lewis: "Loans were granted on the presumption that housing prices would follow trends experienced since 2000, and continue to increase. After all, nominal housing prices had not fallen on an annual basis since

[4] The data is from the St. Louis Federal Reserve Bank. Instructions on how to automatically download data and summarize the data can be found on the website www.edbodmer.com.

World War II. According to one story, an investor called the rating agency Standard & Poor's and asked what would happen to default rates if real estate prices fell. The man at S&P couldn't say; its model for home prices had no ability to accept a negative number. 'They were just assuming home prices would keep going up…'"[5]

Figure 2.4 displays surplus capacity in housing industry with a graph of the inventory of vacant homes for sale. Vacant homes reached their peak shortly after prices were spiking in 2006. This is the inverse of what normally occurs from the standpoint of basic supply and demand analysis where an excess of inventory would normally imply low prices. As with the demand and supply in Figure 2.3, this public data indicated that there was surplus capacity in the market and a danger of prices crashing should not have been surprising. At the time, supply and demand data was apparently ignored.



The AES Drax case discussed in Chapter ___ , the peaker plant case discussed in Chapter ___ and the Quezon case in Chapter ___ involve declines in prices that occur after periods of surplus capacity for capital intensive industries and the effects on equity and debt valuation. Once historic industry data is acquired for corporate finance analysis or benchmark information is developed for evaluation of project finance, the question of whether this information can be used in future projections depends on some kind of industry analysis and cannot be evaluated just by looking at recent price trends. If the investment is made in capital intensive industries, the potential for surplus capacity is a key question of

[5] Lewis, ibid.

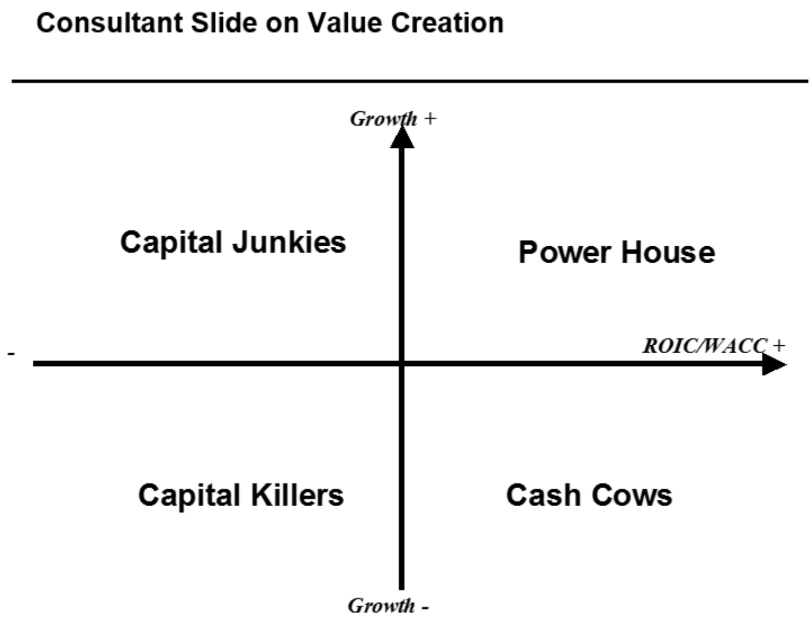
whether the historic or benchmark information can be assumed to continue. In contrast, problems of price volatility driven by surplus capacity is less pronounced for non-capital intensive sectors. When there are too many street vendors in Prague selling sausages, the vendors can close down and perhaps move somewhere else or even change professions. The surplus capacity then goes away quickly. For real estate, telecommunication, oil production, electricity generation and many other capital intensive industries, when surplus capacity arises it does not go away for a long time and the excess can cause prices to suddenly move from above long-run marginal cost to short-run marginal cost.

Believing that High Returns can continually be earned in Non-Monopoly Industries

Perhaps the most basic notion about valuation is the idea that value comes from earning returns above the cost of capital. This fundamental concept will be used in later chapters when developing financial models of valuation and the idea will be discussed in other case studies. Companies that have generated enormous value such as Google, Microsoft, McDonalds and Apple have earned returns above their cost of capital and also at the same time been able to grow their business. These companies would be put into the power house square of the matrix shown on Figure 2.5. Power house companies that are able to sustain a return on investment – ROIC or project IRR – above their risk adjusted cost of capital – WACC – and also grow at the same time will have increases in stock price, high P/E ratios, price to book ratios far above 1.0 and generally revered in by financial analysts. These companies have been able to gain some kind of monopoly power by virtue of their size, their marketing or perception that their products cannot be copied. This can come from making people addicted to your coffee or soft drink (Starbucks and Coke); developing a media empire that makes people believe they can only be happy if they spend time waiting lines for special rides on machines that last a couple of minutes and have their pictures taken next to a cartoon character (Disney); getting people used to using your software and becoming large enough to buy companies like YouTube (Google); or making teenagers addicted to computer games (Microsoft and Xbox).

The valuation problem with the matrix shown on Figure 2.5 is that other individuals and companies want to believe they are also in the powerhouse square, but their situation is temporary. When competitors can move into an industry after seeing high returns, surplus capacity can suddenly arise and price declines dramatically reduce rates of return. Suddenly, the companies are no longer in the power house square but rather in the worst square of all, the capital junkie square. Their value plummets, the P/E ratio crashes and the price to book ratio falls to

below 1.0. This issue is central to the First Solar case study in Chapter ___ and the Kitty Hawk case study in Chapter ___.



In the run-up to the housing crisis and the fall in real estate values, individuals and corporations implicitly believed they were in the power house square, but they were not doing anything very special at all. Before the housing crisis, many people believed they had some kind of special skill in buying houses, borrowing money and then re-selling the house. Similarly, large investment firms believed they were doing something unique by putting together loans in a package and re-selling the loans. People who bought and re-sold houses when the prices were increasing were could make high returns when the increase in housing prices was more than the interest rate. The ROIC in Figure 2.5 could be thought of as the increase in housing price and the WACC would be the cost of borrowing. Naturally, and more people wanted in on the action. Large financial corporations like Lehman Brothers were making a lot of money through buying mortgages and then re-selling the mortgages enabling them to earn large fees without making a direct investment. Evidence of the high returns made by these kind of financial corporations were the large bonuses paid to just about all of their employees. The idea of making a profit through borrowing money to buy and re-sell houses is explained as follows: “a surprising number of sub-primes went to affluent people stretching for second homes.”[6] “[L]enders welcomed “flippers” – people buying houses solely for the purpose of reselling in a year or so. By 2005, 40% of all

[6] Richard Bittner

home purchases were either for investment or for second homes….a large share of the ‘second homes’ actually were speculations for resale.”[7]

As in so many other cases such as the Dahbol case from Chapter ___ and the Petrozuata case from Chapter 3, the valuation lesson is that when making an easy return seems too good to be true it probably is. The returns being earned were only possible by taking a big risk that the price of houses would not fall. As more and more people went into the market and pushed up the price of homes, the probability of home values falling increased. When this happened, people who were flipping homes were left with loans that did not come close to covering the value of the house were left “underwater.” Financial institutions that paid large bonuses were left with mortgages that had a far lower value. With hindsight, believing that you are in the powerhouse square when you were doing nothing special was a very dangerous strategy as is paying a high P/E ratio for a company that is in a competitive business. People and financial institutions that had been so anxious to grow their business suddenly found themselves in the capital junkie square of Figure 2.3 where a lot of money is thrown away on investments that do not cover the opportunity cost of capital.

The implication of this return on investment lesson from the financial crisis to corporate and project finance analysis is to carefully analyze projected returns on capital as the starting point of an investment analysis. In project finance, if an investment is projected to earn a high return and others can make similar investments, the first question that must be asked is how this situation can be possible (as was the case for merchant electricity plants discussed in Chapter __). For corporate analysis, when a financial model forecasts that the return on investment will increase or even when the return will remain high, you should stop and ask what is so special about the company (as for the solar industry before 2012 discussed in Chapter ___).

Credit Analysis that Extrapolates from the Wrong Data in Evaluating Repayment Probability

Valuation analysis in this book addresses the manner in which debt is evaluated as well as how to analyze equity investments. Many of the case studies in subsequent chapters involve losses on debt as well as declines in the value of equity. Flaws with the credit analysis and valuation of debt securities were without much doubt the analytical factor in bringing down financial markets during the

[7] Charles Morristo

financial crisis. Mistakes in debt valuation and credit analysis that lead up to the financial crisis involved problems both in terms of individual loans such as the sub-prime mortgages that were offered and difficulties with credit analysis of loan packages called collateralized debt obligations (CDO's) or collateralized mortgage obligations (CMO's). The credit analysis of the individual sup-prime loans are closely related to packaged loans because the loan packages consisted of various aggregations of the individual debts. One of the principal drivers of the financial crisis was the inappropriate way the potential defaults on the individual loans were evaluated.

From the perspective of financial theory, there are many analogies between debt and equity. Both debt and equity involve understanding appropriate benchmarks. For equity, the benchmark may be the P/E ratio, the EV/EBITDA ratio or the P/E ratio. For debt the benchmark could be debt to equity, DSCR or the debt to EBITDA ratio. Both debt and equity analysis involve cost of capital analysis. For equity, cost of capital can be estimated by the CAPM or another technique such as a regression analysis of the price to book ratio discussed in Part 2. For debt, cost of capital involves measuring credit spreads and the probability of default. Finally, both debt and equity require some kind of explicit or implicit forecast that should reflect economic theory and may include stochastic mathematical analysis. These subjects are addressed later on in the text.

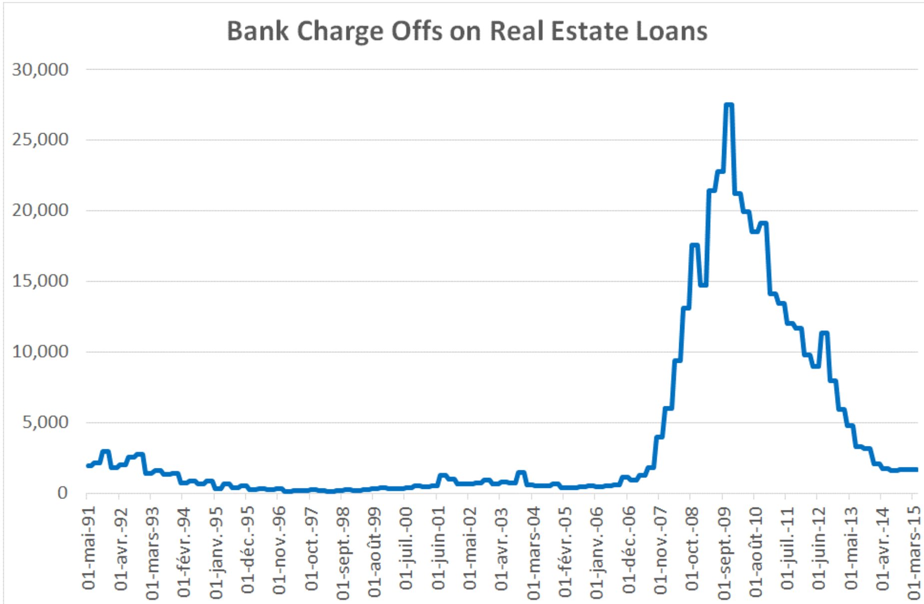
In considering problems associated with lending practices, subprime loans can be used to illustrate the valuation flaws. According to one source, sub-prime lending jumped from an annual volume of $145 million in 2001 to $625 million in 2005 and represented more than 20% of total new debt issuances.[8] To demonstrate flaws in valuation that were part of the financial crisis, consider a product called a NINJA loan. The letters of this financial product meant No Income, No Job, and no Assets. While the loan terms in the NINJA documents were extreme and applied at the peak of aggressive lending before the financial crisis, the thinking that went into this type of loan demonstrated flaws in credit analysis that started with the general idea that loans could be made solely on the basis of the value of the home that was purchased. Examples other than NINJA loans were stated income loans where income was not documented and loans where "brokers would grossly exaggerated income and arrange two mortgages... one a loan for her down payment, the other an adjustable rate mortgage on the home." Presumably the notion was that as long as the value of the home increased, even if a borrower had no income, no job and no other assets, as long as the home could be sold at a value more than the amount of the loan, the debt could still be repaid. Further, people who borrowed money on this basis did not have much if any money to make a down payment on a house, and therefore amount of the loan relative to the value of the house was high. Understanding the basis upon which individual loans were made to people buying houses was probably more important than worrying how

[8] Source:

loans were put together in complex packages, as the value of the loan packages at the end of the day were made up of individual loans.

When performing credit analysis that is the basis for valuing loans, bankers and other lenders should begin with the fundamental question of how loans will be repaid. Three general methods of repayment include: (1) payment of debt service (interest plus principal payments) from cash flow (salaries for an individual, EBITDA for a corporation); (2) payment of loans by making new loans, meaning that the loans will be re-financed because of confidence in the strength of the company or individual and the potential for future cash flow generation; or (3) payment of loans by selling the assets that are the collateral for making the loans. Responsible lending generally means that at least two of the repayment sources are evaluated and asset sales are generally termed the second way out. In determining the probability that loans will be repaid, each of these sources of repayment can be calibrated to financial ratio benchmarks. Repayment from cash flow can be measured through a debt service coverage ratio (DSCR) that gauges the percentage reduction in cash flow that can be withstood before a loan defaults. Relationships between the DSCR and the probability of default are a function of the volatility of cash flow. With more cash flow volatility, higher debt service cushions are required. Re-financing can be evaluated by computing the ratio of the debt to the cash flow as an indicator of how long it takes to repay debt. Losses that are experienced after a default can be measured by the loan to value or the debt to equity ratio which evaluates how low the asset value can fall after a default arises. NINJA loans and sub-prime lending in general ignored the potential for repayment from cash flow or re-financing and concentrated on the source of repayment from selling assets.

In evaluating loans and using benchmarks, lenders can apply the historic track record of defaults as well as the amount of money that is recouped after the loan defaults (probability of default and loss given default) to assess the risk of the loan. The statistical analysis could consider the three repayment methods discussed above including some measure of debt service or interest coverage, ratios that gauge the size of the loan to the cash flow and the loan to value or debt to capital ratio. As the sub-prime lending was more aggressive than historic practices, the probability of default could be extrapolated even if specific data on the aggressive subprime loans was not available. For example, the probability of default on a conventional loan may be in the range of 3% and the probability of default on sub-prime loans could be extrapolated to something like 7%. The dramatic change in defaults on real estate loans during the housing crisis relative to historic levels is demonstrated on Figure 2.6. The graph shows that historic charge offs did not provide any indication of what was about to happen. Statistical extrapolation of historic data did not work.



Problems with this type of extrapolation when very different loans are made can be demonstrated using analysis of the ratio of loan to value. Consider an extreme case of a 100% loan to value ratio and assume an equal probability of housing prices increasing or decreasing. In this situation if there is a 50% chance that the value of the asset will fall and a 50% chance that the value will increase, meaning the probability of default is also 50%. If the loan to value ratio was 70% instead of 100%, then the house prices could fall by 30% before defaults would occur from the standpoint of repayment from asset sales. If fact, as demonstrated by the graphs of the value of homes shown in Figure 2.2, the there was a higher probability that the value of homes would decline than they would increase meaning that the probability of default was very high. The problem of declining values is compounded by a basic principle of lending which dictates that if you don't put your own money into an investment, you care a lot less about the investment.

Lessons learned from extrapolating historic default statistics to the very aggressive and fundamentally different forms of loans that were being made are documented by a comment that "[t]he 'class of 2005 and 2006' borrowers were defaulting much faster than households which had taken out mortgages before those dates." As further demonstration that extrapolation of history could not be used for the different loans, the value that was experienced after default, or the loss given default was also much worse than amounts that would be expected from historic experience: "A particularly pernicious aspect of the defaults was that when this new breed of subprime borrowers walked away from their homes, they often left them in such a bad state that it was hard for lenders to realize any value from the repossessed properties. Until the autumn of 2007, Moody's had assumed,

on the basis of past housing cycles, that lenders could recoup 70 per cent of their loans in case of default. By October 2007, it had slashed that projection to just 40 per cent." Cases in which mistakes in lending were made include Petrozuata (Chapter __), Kitty Hawk (Chapter __), AES Drax (Chapter ___) and, most of all Eurotunnel (Chapter __) and Iridium (Chapter ___).

Failure of Fully Thought-out Downside Scenario Analysis in Evaluating Risks Associated with Contracts

In evaluating all sorts of project financed investments, one of the fundamental tenets is that risks to an investor can be reduced through signing contracts and transferring risk to the contractor. Investors and lenders may think the risk analysis can stop as soon as the contracts are in place. However a potential problem with this type of analysis experienced in many of the subsequent case studies is that if contracts do not make economic sense, the chances of the contracts being not being honored can be high. If prices in the contracts are high relative to market benchmarks or other contracts (often because of perceived political risk), then the risk of the contract being broken increases. This is the primary subject of the Enron Dabhol Plant discussed in Chapter ___. Risk analysis of contracts should begin with whether the contracts are economic from the perspective of the person or institution making payments and the implicit trustworthiness of the party to make continued payments when the contract is not economic. Similarly, evaluation of subprime loan contracts that were made in the years leading up to the financial crisis should have considered both the economics from the perspective of the people paying mortgages and what actions would occur after contracts were not economic from their perspective. This kind of analysis should have included consideration of scenarios that go all the way from evaluating the economics of the subprime contracts to the affordability of the contracts for the ultimate person paying the bill. A downside scenario should have included the possibility of an economic recession. Similar issues occur in many of the other cases including Petrozuata (Chapter ___), Dahbol (Chapter ___), Quezon (Chapter ___), Eurotunnel (Chapter ___) and Iridium (Chapter ___).

Subprime contracts were famous for having relatively low interest rates at the beginning of the loan that increased by a large amount a year or a few years on. According to one source: "[m]ost investors built their pricing models around the sweet spot, the two-year adjustable mortgage with a three-year prepayment penalty, because it maximized revenue for everyone in the food chain." Loan contracts are different than long-term contracts with fixed prices because values in

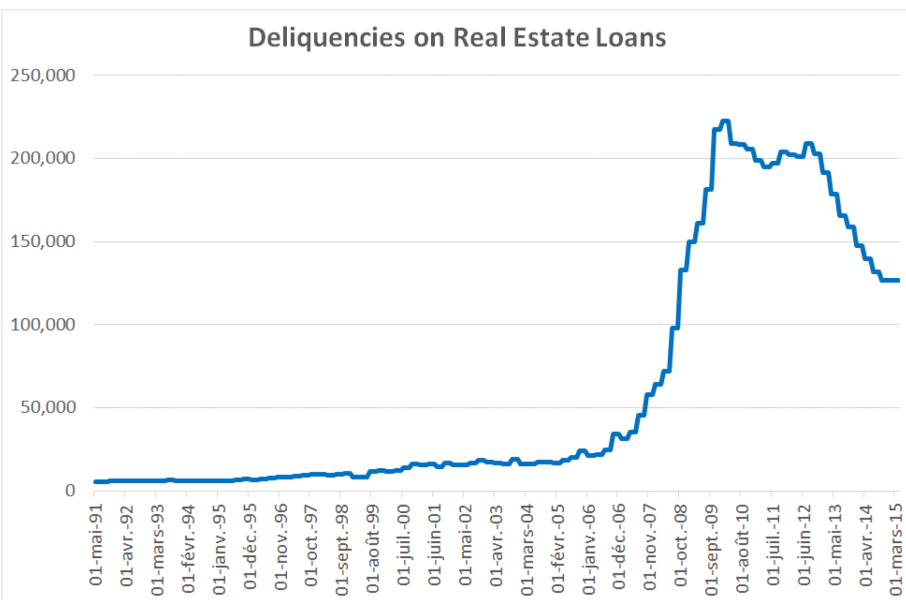
loans have to fall before the loans become uneconomic from the perspective of the person who makes payments on the contract. In long-term fixed price contracts like purchased power agreements for electricity generation, as soon as a reference price changes relative to the contract price, then the contract becomes uneconomic for one party or the other. Say a contract is signed for 10 years at a price of 100. If the price falls below 100, then the payer of the contract will be unhappy as he could buy whatever is in the contract for at a lower price. On the other hand, if the market price rises, then the supplier who receives contract payments rather than the buyer is upset because he could sell stuff to somebody else for a higher price. In the case of loans, there is generally a buffer before one or another party is disappointed. In the case of a real estate loan, if the loan is for 70 and the value of the house has a value of 100, the payer of the contract does not have a desire to get out of the contract until the price value of the house falls below 70. The lender is happy as long as payments for the contract is honored which should happen when the price is above 70.

The long-term fixed price contract could be termed a forward contract while the loan contract could be called an option contact. Evaluation of the contract with scenario analysis should first consider if the payer (the home buyer) will be unhappy; and, second, whether the buyer will continue to make contract payments when the contract is no longer economic from his perspective. Laying out the problem in this way practically provides the answer of what happened to subprime debt in the financial crisis. A scenario could easily be constructed where house prices fall, loan contracts become uneconomic and people are do not honor the contract after experiencing increased interest rates because, among other things like not understanding that the interest rate increases would occur, they simply cannot afford the debt service. With hindsight, this scenario that went all the way to the affordability of the contracts was not only possible, but should have been expected.

Scenario analysis of subprime loan contracts would probably have been a lot more helpful in evaluating the probability of default and the loss given default than statistical analysis discussed in the last section given the difference between these loans and more traditional loans. If the loan to value was close to 100%, then the contracts are really more like long-term fixed price contracts. Typical loan contracts have a buffer before the loan value exceeds the asset value. But if the loan value was close to the value of the home when the contract was signed, then as soon as the value would fall, the borrower would want to get out of the contract. Given the picture of housing prices in Figure 2.2, this was certainly not a crazy scenario. Once the contract is out of the money or the house is underwater, the next question in the scenario analysis is what happens in terms of whether the home buyer will continue to honor the contract. For subprime loans, after the interest rate increases, it became difficult for many people to afford the contract payments even if they wanted to make the debt service payments and honor the

contract. Thus, when the scenario is carried all the way to the ability to pay, the chances of default as well as the loss given default on the contract were in fact quite high. A scenario with 50% probability of default would not have been out of the question.

In making subprime loans with a high probability of default and loss given default, the interest rate that was required to account for the risk of the loans would have to be very high. Part 3 of the book discusses how the required credit spread or the cost of capital for debt can be approximated by the probability of default multiplied by the loss given default. If the probability of default is 20% and the loss given default is 60% then required credit spread would have to be at least 12% plus the base interest rate. This high interest rate may itself make the payments unaffordable. This high interest rate that is analogous to a country risk premium poses a dilemma that occurs in other case studies discussed later on as it did for subprime loans. When contracts are signed, you are supposed to pay off the contract even if it goes against you. But if somebody purchasing a home was very conscientious and tried to make debt service payments on a loan, it may be very difficult because of the required recovery from others who do not pay their loans. This can create a viscous circle. The interest rate must be high enough to recover losses after default, but the higher interest rate makes the loans unaffordable. The lack of affordability makes the default probability and the required spread higher. Continuing problems with people not paying their mortgages continued long after the initial housing shock. Figure 2.8 shows the rate of delinquency on all housing loans, of which subprime loans were a small fraction. The high rate of delinquency peaked in the middle of 2010 and continued long after the recession.



To demonstrate how scenarios actually played out in the financial crisis, the falling prices and loan defaults created a further viscous circle where housing values fell because of the loan defaults as illustrated by the following comment: “To add to the confusion, by the autumn of 2007 it seemed that events in some US neighborhoods were throwing the ratings agencies’ models off even further. As house prices fell, defaults were rising to such a degree that they were blighting entire areas. That was pushing house prices lower still, sparking yet more defaults.” This type of viscous circle where contract prices must cover inflated estimates of the country risk is present for Petrozuata (Chapter ___) and Enron Dahbol (Chapter ___).

Use of Simple Analytical Checks and Avoiding Unnecessary Financial Jargon

Discussion of blunders that were made in the lead up to the financial crisis has not yet mentioned those complex toxic securitized investments that many people claim were a big cause of the crisis because they are just too difficult to analyze. During the financial crisis, experts regularly appeared on television programs and used fancy financial language that and discussed credit default swaps, multiple debt tranches, structured investment vehicles, collateralization, systematic risk and many other sophisticated terms. Films and books on the financial crisis made it seem that all of this finance business was just too complicated for the average layperson to comprehend. Suggestions were made that the sophisticated securities should be outlawed or heavily regulated because they were too difficult to analyze. People who read a little about the crisis would proudly explained how mortgages were put together into a structured finance instrument and then cash flows of that thing would be distributed to different investors. The complexity of modeling is noted as follows: “The problem is that these instruments have become so incredibly complex that you need incredibly sophisticated computer models to work out their value.”

The root of the financial crisis was the bubble in house valuation combined with bad lending practices at an individual loan level. The key to understanding what went wrong is understanding these fundamental economic issues and not going through a thirty page financial model. Sudden declines in the value of the complex CDO securities is not difficult to grasp once the economics of the underlying assets such as subprime loans measured. To demonstrate problems in valuation of loan packages, you did not need some highly elaborate financial model. Instead, a relatively simple structured finance model discussed in the next couple of paragraphs can demonstrate the problems with the so-called toxic investments and verify that the top-tier debt was not all that safe. This failure to

check seemingly complex analysis with basic cash flow models was a further analytical mistake made in the financial crisis. Similar failures to perform relatively simple analysis that demonstrated problems with business concepts are present in just about all of the case studies discussed in subsequent chapters.

One explanation of the collateralized securities that is enough to set up a financial model is the following: "Mortgages were transferred to a trust and then sliced or tranched horizontally into different segments, with different bonds for each segment. The trick was that the top-tier bonds, which represented say 70 percent of the value sold had first claim on all cash flows. Since it is inconceivable that 30 percent of a normal mortgage portfolio can default, top-tier bonds go triple-A, super safe ratings and paid commensurately low yields."[9] In terms of making a financial model, the bonds can be modeled as a cash flow sweep given that these bonds had the first claim on cash flows. Modeling this financial structure involves setting-up a debt schedule and connecting repayments to the assumed cash flows generated from mortgages.

After the financial crisis began, the effect of increasing defaults on the risk of a collateralized security was described in the context of defaults: "When the sub-prime CDO market first took off in 2005, sub-prime mortgage defaults were only 3%. A 20% cushion of equity and subordinated debt seemed like ample protection, so rating agencies generally assigned triple A to the top 80 percent of bonds in the CDO. Actual default rates were more than 10% and rising." [10] Default rates on individual loans that were much higher than 10% were very predictable, albeit with hindsight, from the combination of large decreases in housing prices, high loan to value ratios and the unlikeliness that people who have underwater mortgages will continue to honor loan contracts. Developing a financial model with different default rates, losses after default and interest income proceeds from the original loans can be structured as the source of cash flow, much like rental proceeds on a commercial building. With assumptions made for cash inflows from mortgages, the construction of a simple financial model that can evaluate what happens when the probability of default changes as suggested by the above quote along with rising loss given default rates.

One of the failings in many financial analyses and financial models these days is the problem of falling into a financial jargon trap without developing a simple way to verify the riskiness of an investment. To understand how CDO's worked and what happened to their value when defaults trended upwards, a relatively simple financial model with a cash flow waterfall can be built. You do not have to construct a whole lot of different sheets or to incorporate complex

[9] Jones, Sam, "The formula that felled Wall St", April 24 2009, The Financial Times Limited 2009, http://www.ft.com/cms/s/2/e3b972fc-3aa6-11de-8a2d-00144feabdc0.html

[10] Tett, Gillian, How panic gripped the world's biggest banks, May 8 2009 http://groups.google.com/group/misc.invest.stocks/browse_thread/thread/bc3ea42a6f0acd25

stochastic equations. You simply need to know how to use the minimum function in excel spreadsheet and, more importantly, organize your thinking and your model in a logical and structured manner that reflects how the loans will be repaid. The model organization should separately emulate how the sub-prime money inflows arise and where that money goes. You begin with a few assumptions about the interest rate received on the subprime debt and the interest rate paid for top-tier bonds. In modeling how much money is received, you also need inputs for the probability of default and the loss given default. Once you create a model and think about scenarios where housing prices fell below the value of loans and where people did not make contract payments, you can use the model to see that the top-tier bonds were not really that safe at all. You do not have to be an expert in systematic risk, collateralization or credit default swaps.

If you want to see the details of how the models are constructed, you can go to the associated website www.edbodmer.com and watch a YouTube video that works through the model on a line by line basis.[11] As the length of the video explaining how to build the model from scratch is less than half an hour, you will hopefully agree that the model is not some kind of highly complicated analysis that only a few highly paid financial experts could construct. Figures 2.9 through 2.12 demonstrate parts of the simple structured finance model. The model begins with laying out assumptions for timing inputs, cash flow sources from sub-prime loans and default statistics. Assumptions for financing the structured finance vehicle is included after the inputs for the cash inflows. After setting-up the assumptions, the financial structure is presented in terms of a sources and uses of funds analysis. A key part of the model is computing the revenues realized from subprime mortgages after accounting for defaults and recoveries of loans that are not paid. This is just like any other financial model where the most important element is modelling revenues, expenses and capital expenditures.

With cash inflows established, the financing structure can be developed. This involves first structuring the balance of the top-tier debt and then connecting the repayment of the debt to a cash flow waterfall. The cash flow waterfall puts various parts of the model together. Cash inflows from the subprime mortgages are put on top of the waterfall. Then the cash flow is used to the maximum extent possible to pay off the top-tier debt through displaying some cash flow sub-totals and using the minimum function in excel (paying the lesser of the available cash flow or the beginning debt balance). Once the top tier debt is paid, the remaining cash flow is paid to the equity investors. The final part of the model computes the cash flows to the debt and equity investors and computes the IRR on the cash flow. If the IRR on the top-tier debt is below the stated interest rate, then a loss on

[11] The modeling techniques are documented in book Corporate and Project Finance Modeling, Theory and Practice. Bodmer, Edward.

the top-tier debt has occurred. Multiple different tiers could easily be computed for different structures by using the minimum function for each tranche.

Figure 2.9 shows how the assumptions are laid out in the simple CDO model. Some of the assumptions for the financial structure of the investment are on-time inputs that are constant over time. Other assumptions that can vary over time are shown on a year-by-year basis. The only assumption that is difficult to get your hands around is probability of default. If a probability of default of 15% per year on subprime is assumed, more than 50% of the loans default on a cumulative basis by year 5. The scenario shown on Figure 2.9 assumes a default rate of 5% for 4 years followed by the assumed stable default rate of 2%. By year 30, this results in a cumulated default rate of 48%. When presenting the model, years 1 through 5 and years 25 through 30 are displayed in order so that the model can fit on a page. Statistical analysis on historic default rates can be interesting, but it did not provide any insight with respect to realistic default rates. Assumptions shown in Figure 2.9 are hidden for the middle periods of the model.

Financial Structure Assumptions												
Amount of Subprime Loans	1,000.00			Project IRR		4.56%						
Loans/Equity	5			Equity IRR		5.91%						
Equity to Assets	20%			Debt IRR		3.50%						
Fees	7.00%											
Subprime Repayment Years	30.00											
Years of High Default	4.00											
Stable PD	2.00%											
Annual Assumptions		1	2	3	4	5	25	26	27	28	29	30
Rate Charged on Sub-prime Loans		6.50%	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%
High Default Period		TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
PD		5.00%	5.00%	5.00%	5.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Cumulative Loans Current	1.00	95%	90%	86%	81%	80%	53%	52%	51%	50%	49%	48%
Cummulative Default Percent		5%	10%	14%	19%	20%	47%	48%	49%	50%	51%	52%
LGD		30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
Delay in Recoveries		2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Interest Rate on Top-tier Debt		3.50%	3.50%	3.50%	3.50%	3.50%	3.50%	3.50%	3.50%	3.50%	3.50%	3.50%

Figure 2.9 – Set-up of Assumptions in Simple Structured Finance Model

After the assumptions are developed, the sources and uses can be reported as shown in Figure 2.10. The sources and uses analysis is like a mini balance sheet and for the simple model it shows how much money is spent to buy subprime mortgages and to pay all of the fees to various parties. After compiling the amount spent, the amount to money coming from various sources and invested in the venture is displayed. A sources and uses statement is presented for each of the project finance cases in subsequent chapters. If equity is input into the project and the top-tier debt is reduced, the investment can absorb defaults and losses on default while still being able to fully repay the debt. If less equity is in the sources of funds, there is less buffer before which losses on the top-tier debt is realized.

Figure 2.10 assumes 20% equity corresponding to the example cited above. A lot about the structured investment can be understood by looking at this simple little statement.

Part 1: Sources and Uses of Funds		
Uses of Funds	Amount	Percent
Purchase of Subprime Debt	1,000.00	93.46%
Fees	70.00	6.54%
Total Uses	1,070.00	100.00%
Sources of Funds		
Top-tier Debt	856.00	80.00%
Equity	214.00	20.00%
Total Sources	1,070.00	100.00%

Figure 2.10 – Sources and Uses of Funds in Structured Finance Model

After the sources and uses, the next part of this, or any other, model derives the cash inflows that are earned by the investment and that will be used to pay off the debt and equity that pay for the assets. For the subprime debt, the cash flow depends on three items. First, the debt service paid by homeowners is computed from the sub-prime loan interest rate with the interest rate increases, the prepayment fees and so forth. Next, the debts are adjusted for the amount of interest that is not paid because of default. Finally, the amount of recoveries is incorporated using the loss given default assumption. The cash inflow table that depends on the non-defaulted debt is shown on Figure 2.12. The example in Figure 2.11 shows that by the end of the mortgage the total loan balance is repaid. Recoveries of loan defaults are assumed to occur three years after the default occurs.

Part 2: Cash Flow Inflows from Subprime Assets													
Balance of Subprime Debt and Cash Inflw		1	2	3	4	5	25	26	27	28	29	30
Opening Balance		1,000.00	968.65	937.44	906.33	875.31	279.67	237.68	193.97	148.46	101.03	51.59
Less: New Defaults for Year		20.00	19.37	18.75	18.13	8.75	2.80	2.38	1.94	1.48	1.01	0.52
Less: Repayment of Loans		11.35	11.84	12.36	12.90	13.60	39.20	41.33	43.57	45.94	48.44	51.07
Closing Balance	1,000.00	968.65	937.44	906.33	875.31	852.95	237.68	193.97	148.46	101.03	51.59	0.00
Interest Income		65.00	62.96	60.93	58.91	56.89	18.18	15.45	12.61	9.65	6.57	3.35
Recoveries from Defaults												
New Defaults		20.00	19.37	18.75	18.13	8.75	2.80	2.38	1.94	1.48	1.01	0.52
Recovered		14.00	13.56	13.12	12.69	6.13	1.96	1.66	1.36	1.04	0.71	0.36
Delayed Recoveries		FALSE	FALSE	FALSE	14.00	13.56	2.77	2.51	2.24	1.96	1.66	1.36

Figure 2.11 – Cash Inflows from Sub-prime Loans in Structured Finance Model

After the cash inflows are established, a table of the debt repayments should be constructed. The debt schedule always lays out the opening balance,

how the debt is repaid and the interest expense. For this model, the repayment of debt comes directly from the available cash flow that is computed in the cash flow waterfall. A provision for non-payment of interest expense is also incorporated in case the cash flow is not even enough to pay the interest. The amount of interest that cannot be paid also comes from the case flow waterfall. Figure 2.12 displays the part of the model for both the debt schedule and the cash flow waterfall. The only formula that is in the least bit complex are the formulas for debt repayment and for the defaulted interest. These formulas must consider whether the cash flow is negative or positive as well as the maximum level of the default. In the example shown in Figure 2.12, the debt is fully repaid by year 25 meaning the dividends can then be paid to equity.

Part 3: Debt Repayment Schedule for Top-tier Bonds		1	2	3	4	5	25	26	27	28	29	30
Opening Debt		856.00	809.61	763.15	716.56	655.83	0.00	0.00	0.00	0.00	0.00	0.00
Less: Repayment from Cash flow Analysis		46.39	46.47	46.58	60.73	61.10	0.00	0.00	0.00	0.00	0.00	0.00
Add: Defaulted Interest not paid		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Closing Balance	856.00	809.61	763.15	716.56	655.83	594.73	0.00	0.00	0.00	0.00	0.00	0.00
Interest Expense		29.96	28.34	26.71	25.08	22.95	0.00	0.00	0.00	0.00	0.00	0.00
Part 4: Cash Flow Waterfall												
Interest Income		65.00	62.96	60.93	58.91	56.89	18.18	15.45	12.61	9.65	6.57	3.35
Add: Repayment		11.35	11.84	12.36	12.90	13.60	39.20	41.33	43.57	45.94	48.44	51.07
Add: Recoveries		FALSE	FALSE	FALSE	14.00	13.56	2.77	2.51	2.24	1.96	1.66	1.36
Net Cash Flow		76.35	74.80	73.29	85.81	84.06	60.15	59.29	58.42	57.55	56.67	55.78
Less: Interest Expense		29.96	28.34	26.71	25.08	22.95	0.00	0.00	0.00	0.00	0.00	0.00
Cash Flow for Debt Repayment		46.39	46.47	46.58	60.73	61.10	60.15	59.29	58.42	57.55	56.67	55.78
Repayment of Debt		46.39	46.47	46.58	60.73	61.10	0.00	0.00	0.00	0.00	0.00	0.00
Equity Payment		0.00	0.00	0.00	0.00	0.00	60.15	59.29	58.42	57.55	56.67	55.78

Figure 2.12 – Cash Inflows from Sub-prime Loans in Structured Finance Model

Once you build the model with these few sections, you can see the difficulties in construction a packaged security from subprime loans. If the equity investors are to receive a good return, there must be a big spread between the interest rate earned on subprime loans and the interest rate paid on the top-tier debt. If the interest rates on the sub-prime debt and the top-tier debt were similar, then there would be nothing left for equity holders. This means the top-tier bonds had to get a good credit rating. If there was a lot of equity put into the structured investment, the IRR for equity investors also declines. Using the model the structuring challenges are demonstrated. The interest income must cover (1) defaults from the subprime mortgages; (2) payment of fees; (3) debt service on top-tier debt and (4) payments to equity investors. The trouble is that the cash flow earned from subprime debt was not enough to go around to all of these parties.

More important than illustrating structuring difficulties in setting-up collateralized debt instruments, the simple model shows that the top-tier debt could not be classified as very low risk with almost no chance of default. For a loan to be rated AAA there would have to be virtually no chance that the loans

could default. In terms of our model, this implies that no reasonable default probability and loss given default could result in the IRR on the top-tier debt being lower than the stated interest rate. Using a sensitivity tool in excel (the data table), defaults on the top-tier debt are illustrated in the Figure 2.13. The question raised by this table is whether the scenarios that are shaded in the table are conceivable. If the credit rating is AAA, they do not have to be likely. For the top-tier debt to have a very high rating, the scenarios that are shaded would have to be virtually impossible.

Years of High Default			5.00			
			Loss Given Default			
		30.00%	40%	50%	60%
	3.00%	3.50%	3.50%	3.50%	3.50%
	6.00%	3.50%	3.50%	3.50%	3.50%
	9.00%	3.50%	3.50%	3.50%	3.50%
Prob	12.00%	3.50%	3.50%	3.50%	3.50%
Default	15.00%	3.50%	3.50%	3.38%	2.82%
	18.00%	3.50%	3.50%	2.75%	2.10%
	21.00%	3.50%	3.09%	2.11%	1.36%
	24.00%	3.50%	2.58%	1.47%	0.61%
	27.00%	3.48%	2.07%	0.82%	-0.16%
	30.00%	3.11%	1.56%	0.17%	-0.94%

Figure 2.13 – Sensitivity Analysis on Top-tier IRR from Alternative Probability of Default and Loss Given Default Assumptions

Using the scenario analysis described above, the possibility of defaults on top-tier debt was not surprising. Given high loan to value statistics and large declines in the value of homes, it would be surprising if loans did not default. Further, again because of the possibility of declines in housing prices, the loss given default could be 60%. While this scenarios that are shaded may not have seemed highly likely before the financial crisis, the idea of an AAA bond rating was that it was virtually impossible. Default rates could not be simulated from historic data and people could not afford interest rates on the subprime mortgages. One could argue that the shaded areas were not only possible but likely outcomes. The bonds should not have been rated AAA and you do not need a really fancy model to demonstrate this fact. A simple model explains what the collateralized debt was not a viable financial security and it was not responsible to assign a high credit rating to this debt.

Believing that New-Fangled Financial Products Can Change the Fundamental Relationship between Risk and Return

Finance attracts very creative and smart people who are sometimes paid a whole lot of money. One of the objectives of these intelligent people is to come up with innovative new products just like professionals at Google try to come up with new products like goggle glasses. When finance professionals create new ideas and new products they can sound convincing by using fancy terms and talking fast to make sure you will be thoroughly confused. As with other industries, people from the general public want to be part of a new idea that can make a lot of money such as getting in early on a company that produces a new kind of electric car. The new financial products seem to be no different than other innovative products that have the potential to take off. In the financial crisis, investments in structured investment seemed to have earn a better return for a given level of risk than other securities and create value for investors. Companies like Lehman Brothers would make presentations about just how wonderful the products were from an investment perspective. With hindsight we now know that the innovative financial products did not make risk somehow disappear. The implicit belief that financial investments could create value through reducing risk was yet another flaw that occurred in the financial crisis and in other valuation nightmares.

Packaged loans appeared to be able to take a lot of risky loans (you could call them crappy) and make them into safe AAA loans. Perhaps this was should have been called financial alchemy: “The first mortgage-backed bonds were created in the late 1980s… structured finance was a process of pure alchemy: a way of turning myriad messy mortgage loans into standardized, regimented and easy-to-assess bonds...” Innovative investment bankers had somehow seemed to be able to reduce risk and at the same time allowed a whole new class of buyers to own homes. In fact, as demonstrated in the last section, the securities had not reduced risk, but instead transferred risk to different parties in different ways. People could not really afford the mortgage on homes and there was not enough cash flow to create AAA on top-tier debt and provide adequate returns to junior investors. The only magic from the structured debt obligations was to convince rating agencies to assign less risk to the top-tier and other debt than they should have as explained in the previous section. The valuation lesson here is that when a new kind of financial instrument or financial theory appears in finance that seems to create value or reduce risk from nothing, it is probably rubbish. For just about any investment you can earn a lot of money if you understand how cash flow is generated and you are better than others at identifying cash flow trend. But

thinking that you can make a lot of money on the financing side of the equation is different. When moving between one source of funds and another, all that is happening is that risks are being transferred from one party to another.

The structured investment products came on the heels of the dot com bubble when analogous thinking about creating value from new concepts was even more common. At the turn of the century, a popular term was the new economy. For stocks in the new economy, thinking about value in terms of prospective cash flow and risk was considered old fashion. Stocks that did not earn any cash flow could obtain high valuation because they had things like a lot of hits on their website. As with investments that were supposed to somehow reduce risk, most of the companies that did not earn money and for whom it was relatively easy to copy and idea failed.

Using Mathematical Analysis to Simulate Risk when Variables do Not Follow Conventional Statistical Patterns

Rather than using financial models that were relatively simple as described in the section that describes making basic verification checks, in the lead-up to the financial crisis very elaborate mathematical models were applied. These models contained the implicit belief that the manner in which people pay mortgages could be translated into a mathematical equation with probability distributions. These equations could include complex mathematics using correlation factors and something called coplets. Once the equations were established, a Monte Carlo simulation could be made to measure the probability that the top-tier debt would default. As the statistical analysis required historic data and because the housing market had changed in such fundamental ways, the historic data was irrelevant and the mathematical analysis that seemed so sophisticated was worthless. There was no way that payments received from subprime mortgages with high loan to value ratios approximated a normal distribution where historic data on standard deviation could be used to predict future volatility. As in other valuation cases that went bad, presuming that businesses could be represented as mathematical equations ended up providing a very false comfort that the loans were much safer than they really were.

Before the financial crisis, people in banking had become somewhat attached to the idea of using statistical analysis since the Basel II banking accord that was established a few years earlier. Ironically this accord, which is named after a beautiful city in Switzerland, was supposed to assure that a banking crisis would not occur and create systematic risk. Banks were supposed to use

sophisticated mathematical analysis to predict the probability of loss and the loss given default for every loan. In some contexts, using mathematical analysis from an equation that measures potential dispersion can be reasonable. For oil investment, the notion of proven and probable reserves comes for geological analysis that uses geological data. This probability analysis does not depend on human actions and may be reasonable. In the case of wind and solar electricity projects, historic data may also provide a good basis for statistical analysis (even though famous mistakes have been made in estimating wind production). However when it comes to predicting whether a low income household will make payments on a loan that is underwater and gauging the potential dispersion in housing prices during the bubble, predicting dispersion is quite another matter.

The way in which statistical analysis was used rather than examining the scenarios of individuals who borrowed money is illustrated by a couple of comments from people who work for Moody's: "Moody's did not have access to the individual loan files, much less did it communicate with the borrowers or try to verify the information they provided in their loan applications." Instead, Claire Robinson, a 20-year veteran who is in charge of asset-backed finance for Moody's stated: "We aren't loan officers…Our expertise is as statisticians on an aggregate basis. We want to know, of 1,000 individuals, based on historical performance, what percent will pay their loans?"[12] Using statistical analysis, beautiful graphs can be created and sophisticated math can be used, but these

The manner in which mathematical analysis was used in investment analysis before the financial crisis is described as follows for determining the credit rating of a bond: "From an ordinary desktop computer, you start the Moody's rating software. A window opens in which you set the basic assumptions: duration of bond, payment, and collateral details ... and then – click – the simulation is set running. Not once, but a million times, each time with a different outcome. It's the average outcome from all those simulations that gives you a rating. Unfortunately for bondholders, there was a bug in the software. More importantly, the statistical models used to assess complex securities relied on historical patterns of default. This assumed that the past trends continue to be relevant even though sub-prime loans and other mortgages were nothing like loans made earlier."[13] The fundamental lesson is that all of the sophisticated financial models, elaborate mathematical representations of risk, application of intricate finance theory and other analytical tools are irrelevant without being supplemented by a healthy dose of wisdom and business sense. Many learned the hard way that risks associated with lending money to a waitress in who puts no money down on

[12] Tett, Gillian, How panic gripped the world's biggest banks, May 8 2009 http://groups.google.com/group/misc.invest.stocks/browse_thread/thread/bc3ea42a6f0acd25

[13] Jones, Sam, "When junk was gold", Financial Times, October 17 2008, http://www.ft.com/cms/s/0/65892340-9b1a-11dd-a653-000077b07658.html

a $500,000 house cannot be gauged by running thousands of simulations by a credit analyst at Standard and Poor's on the 50th floor of an office building in Manhattan.

And the correlation model was still mapping the housing market as it had been in 1990s, not the grossly inflated monster it had become. On August 10 2004, however, the rating agency Moody's incorporated Li's Gaussian copula default function formula into its rating methodology for collateralized debt obligations.

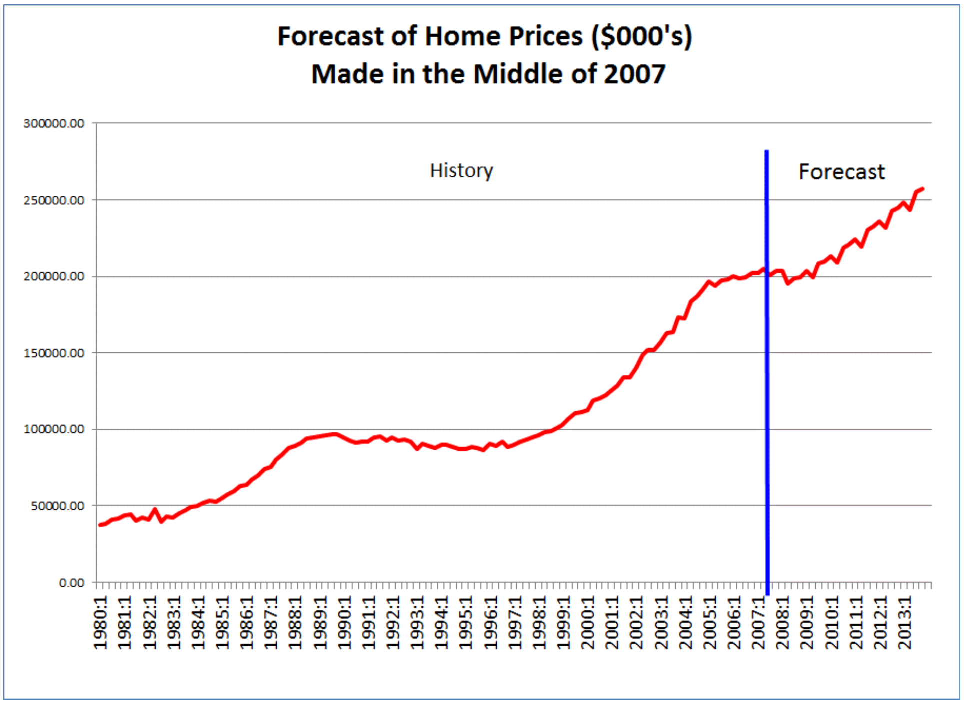
CDOs built solely out of subprime mortgage debt became the rage. And using the magic of the Gaussian copula correlation model, and some clever off-balance-sheet architecture, high-risk mortgages were re-packaged into triple-A-rated investor gold. The CDO market exploded. In 2000, the total number of CDOs issued were worth somewhere in the tens of billions of dollars. By 2007, two trillion dollars of CDO bonds had been issued.

Over-Reliance on Experts who have No Direct Economic Interest in the Investment

Forecasting the future and measuring risk – the foundation of value -- are both very difficult. Because of this it is natural to rely on people who have a good reputation, a fancy degree or who sound very sophisticated to help with the process. For many of the corporate and project finance failures discussed in subsequent chapters, experts gave very bad advice. In the subprime crisis a large reliance was placed on credit rating agencies to assess risk and negative perceptions of rating agency behavior in the financial crisis remains today. The process of making loans for housing investments involved many entities other than rating agencies who got paid but did not take risk by holding an investment. To construct a packaged mortgage investment, many entities that did not hold the loan package (CMO) earned fees. Mortgage brokers solicited and screened applicants. Mortgage banks bid for loans and held them until they had enough to make a CMO. Investment banks designed and sold CMO bonds. Ratings agencies and other entities made big mistakes when measuring the value of various debt instruments leading up to the financial crisis. While various experts ranging from company management to well paid consultants cannot be avoided in the valuation process, the lesson learned from many failed projects ranging from wind farms to toll roads to simple investments in stocks is that the advice should be fully understood and critically questioned.

In the case of projecting housing prices prior to the financial crisis, despite the clear oversupply of housing and the bubble in housing prices, prominent

economic forecasters projected continued increases in housing prices and housing starts. Figure ___ shows a forecast made by the well-known forecasting company Global Insight. The graph shows that despite the historic run-up in prices, future housing prices were projected to continue on their merry way upwards after a small downward blip in 2008. Comparison of the Global Insight forecast demonstrates how shown in Figure _____ with actual housing prices displayed in Figure ___ demonstrates that even highly educated forecasters using sophisticated financial models believed that a pending collapse due to over-supply was not imminent. The few people who got it right went to poor neighborhoods and saw first-hand that people could not afford their mortgage payments.



Problems with reliance on credit rating agencies was a more serious issue in the financial crisis. After Moody's Credit Agency became a publically listed company 2000, its managers adopted the philosophy that it was in the service business rather providing objective information. /one of its executives is quoted as asserting: "We're in the service business, I don't apologize for that."[14] The problem is that entities which receive a rating are the entities that generate revenue and cash flow for the rating agencies. There were stories of analysts from the credit agencies going skydiving with clients of structured finance as well as weekend getaways, golf outings and karaoke nights. As one former Moody's

[14] Financial Times.

staffer recalls: “The change was just precipitous. There was suddenly a concentration on profits. Management got stock options. It’s true there was a big personality shift in the company – lots of cozying up to clients went on.” The bias in incentives is clear. If the rating was too low, entities that wanted a credit rating could go elsewhere. Similar incentive problems exit for companies that prepare reserve reports, traffic studies and wind analyses and clear upward biases that lead to increased valuation can be found in all sorts of other cases. Before the crash in real estate, rating agencies could earn $200,000 from providing a rating that was acceptable to bond issuers. When the housing boom was at its height, the rating agencies attempted to process a very large volume of transactions. The Financial Times quoted an analyst who had to rate a $1 billion structured deal in 90 minutes.

Mistakes made by the credit rating agencies are well documented. In one case Moody’s estimated that a package of loans could potentially incur losses of 2 percent from people not defaulting on mortgages. They were wrong. With the decline in the value of homes and lower incomes, the loan package was revised to have a loss estimate of 27 percent. The value of this package of loans plunged by half and a triple-A layer of bonds was been downgraded 16 notches, all the way to a rating of B.[15] Perhaps if Moody’s made an investment in the bonds, they would have made the same assessment. On the other hand, they may have more fully researched the investment and discovered the potential for losses in a scenario where housing prices fell and mortgages where not paid.

[15] Financial Times, IBID.

Chapter 3

Petrozuata - the Relationship between High IRR and Political Risk

Summary of Conceptual Valuation Errors Made in the Petrozuata Case

Many of the case studies discussed in the remaining chapters of this part of the book use articles published by the Harvard Business School ("HBS") on case histories of particular companies. These case studies can be of interest in studying conceptual valuation mistakes because quite a few people may be familiar with the stories from taking courses in business school. But hopefully, the perspective in the analysis of the cases presented in the next chapters is very different than the business school discussions where management and financial institutions are generally applauded. When you attend business school you are supposed to look-up to brilliant managers who have previously earned a degree from your institution and then write-up a case study about their company. In analyzing cases here, the idea is different. The objective involves evaluating whether valuation problems are due to unpredictable events or result from analytical mistakes that occur regularly. The idea is to investigate valuation mistakes according to the French saying: Le défaut apparaît-il régulièrement ou de manière sporadique ? Est-il possible de le reproduire ?

Some of the remaining cases are not very recent and one may complain that they do not reflect the latest trends in innovative financial products and market conditions. But by using cases where valuation analysis has previously been made and the valuation result is known -- large stock price decline, a bankruptcy, debt restructuring or a nationalization -- a review of why the case failed can be evaluated. With hindsight, the implicit or explicit economic assumptions and theories of valuation that were applied when the investment was made can be evaluated. The case in this chapter involves a famous oil project developed in Venezuela. The company making the investment for this first case was named Petrozuata. The case has been used frequently in business schools as an example of successful application of project finance. In the world of finance, the project

was legendary for a number of reasons including: (1) it was the largest project financing and project bond offering in Latin America to date; (2) it was able to obtain project credit ratings above sovereign credit ratings of Venezuela despite oil price risk; (3) at the time of financing, it had the highest credit rating for a project in Latin America; (4) debt on the project had no political risk insurance despite being located in Venezuela; and, (5) bank loans for the project had the longest maturity to date in Latin America.

The discussion of Petrozuata is derived from various different sources that document the financing and the risk analysis of the project. The primary reference is a Harvard Case Study write-up that is also included in the book *Project Finance Case Studies*.[16] Additional sources include an article written by Professor Benjamin Esty titled *Petrozuata: A Case Study in the Effective Use of Project Finance*.[17] A third source that is particular to this case is an article titled *Petrozuata, Teaching Note*[18] which is available on the internet. This article that is referred to as the Teaching Guide provides an insight as to how business school interpret various issues that are supposed to guide discussion of the case and what kind of analysis is taught to students who are soon to enter the world of finance. Other sources include the arbitration cases concerning nationalization of the project and *Project Finance: Practical Case Studies*[19].

The HBS case study write-up and the associated articles focus on financing of the project and laud the fact that the project finance structure was a breakthrough. Each year various organizations give awards for the best project finance transactions. This is something akin to academy awards that are selected for films in Hollywood. Presumably, there are award dinners after which bankers like actors give irritating speeches congratulating themselves for innovative transactions. The Petrozuata project finance transaction not only won all of the awards, it was even called the "deal of the decade" and praised for the manner it was able to raise capital and achieve investment grade ratings. But this transaction that was supposed to be such a success was nationalized a few years after it began operation and is currently the subject of a bitter dispute about compensation between Conoco, the American company that made 50.1% of the equity investment in the project, and the country of Venezuela. The Petrozuata project was developed in the late 1990's, completed in 2002 and nationalized five years later in 2007.

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[16] Case Studies in Project Finance,
[17] Footnote on date of article
[18] Authored by Mathew Millet in 1999.
[19] Project Finance: Practical Case Studies, Second Edition, VOLUME II, Resources and Infrastructure, Henry A. Davis, Euromoney Books, Nestor House, Playhouse Yard, London EC4V 5EX, United Kingdom, Copyright © 2003 Euromoney Institutional Investor PLC

This chapter addresses why such a highly praised investment ended up being subject to such problems for the Conoco. Instead of simply blaming political uncertainty and an irrational, out of control politician, Hugo Chavez, analytical issues associated with political risk are addressed. Some of the flaws in analysis that led to nationalization can be found by stepping back and asking general questions about who deserves economic rent from oil production and how to evaluate political risk. With the benefit of hindsight, valuation errors that were made in the Petrozuata case and arguably ultimately led to its disappointment for equity investors included:

- Not beginning the evaluation of an investment by analysis of the production cost and the cost structure of an investment relative to competing alternatives.
- Using measures of IRR to evaluate the economic profit on project financings and not considering what it really means to earn a high IRR over a long period of time.
- Not correctly measuring political risk and applying an extremely high equity risk premium to the cash flows and not explicitly measuring the probability of expropriation implicit in credit spreads.
- Assumptions that off-shore accounts and partnership structures can reduce or eliminate political risk.
- Applying Monte Carlo simulation does not answer anything about value, risk or debt structure.

Synopsis of the Petrozuata Case

The HBS case for Petrozuata begins by describing how financial management of the project had a big challenge in finding an optimal mix of financing from different sources. Political and economic problems are then discussed to point out how difficult and expensive the financing would have been had conventional debt issued by state been used. The national oil company of Venezuela named PDVSA, the second largest state-owned oil company in the world, is described in the write-up. However PDVSA had a very low junk-bond rating of single-B that was driven by the credit rating of risks associated with the country of Venezuela. In the early 1990’s Venezuela embarked on a strategy to make investments of $65 billion in the upstream production industry called “the opening.” A PDVSA executive quoted in the case explained that for the company, “the most limited resource … is money.”

Petrozuata was the first of four strategic associations between PDVSA and foreign partners to develop heavy oil. In 1960, Venezuela was a founding member of OPEC and in 1975 it nationalized its oil production limiting private investment. The Petrozuata project and other partnerships that were formed to develop, transport, upgrade and market extra-heavy crude oil from different defined areas in the Orinoco Belt were allowed by legislating an exception to the 1975 law. The Orinoco Belt, located in Eastern Venezuela and north of the Orinoco River, had been largely untapped because of the oil's heavy, high sulfur characteristics, and the lack of infrastructure, markets and investment capital. Deposits in the belt are extra-heavy oil, which is a tar-like substance that acts as a dense liquid underground, but solidifies once brought to the surface. Private investment was permitted by the Venezuela congress in the Orinoco belt through joint venture partnerships with the private-sector partners that were exceptions to the 1975 law.

Petrozuata was the first of the four Orinoco Belt partnerships to be developed. Each of the projects received tax breaks to encourage the investment that were presumably negotiated by the foreign equity investors. Specifics of the tax breaks are outlined in the arbitration reports. A royalty rate of 16.33% was part of the 1943 hydrocarbons law in Venezuela and this royalty was temporarily reduced, for 9 years, to 1% for the Orinoco Belt projects. In addition, the income tax rate of 67.7% that was supposed to be applied to oil projects was reduced to the overall corporate tax rate 34%. Sponsors of the Petrozuata project were a subsidiary of PDVSA named Marven that owned 49.9% and Conoco who owned 51.1%. The oil concession was to last 35 years after which Conoco shares would be given to PDVSA. In the HBS case write-up, Conoco was lauded in the case as being "a leader in the world in both refining technology and project development." The case noted how Conoco had earned the Distinguished Achievement Award from the Offshore Technology Conference.

The project is described by various different sources as consisting of three parts: (1) 530 production wells that apply horizontal rather than vertical drilling; (2) a pipeline system that transports the oil to a port at San Jose; and (3) an upgrading facility to partially refine the heavy crude oil. The HBS case notes that the project has little exploration risk and is termed a development project. The general nature of the project can be seen in Figure 3.1 that displays the sources and uses of funds. A sources and uses analysis is an effective way to paint a picture of the project during from where expenditures are made. The uses and sources statement demonstrates that more than half of the expenditures (60%) are for the upgrader. The estimated oil reserves from the allocated 300 square km area of the Zuata area of the Orinoco Belt of 21.5 billion cover the 120,000 barrel per day capacity of the upgrader by a very wide margin. You can divide 21.5 billion by 35 years and then by 365.25 days to derive potential production from the area. Then you can divide that number by the capacity of the upgrader to derive a margin of

14 times. This simple calculation demonstrates that risks of not producing enough reserves to cover the production of the upgrader was not a serious issue.

	1996	1997	1998	1999	2000	Total
USES						
Capital Expenditures						
Crude Oil Production	$11,995	$191,849	$151,141	$77,092	$16,702	$448,780
Crude Oil Pipeline	655	170,512	45,121	0	0	216,288
Upgrader & Loading Facility[a]	14,345	243,305	510,987	230,306	67,912	1,066,854
Upstream Contingency	0	0	0	0	37,925	37,925
Total Capex	**$26,994**	**$605,666**	**$707,249**	**$307,399**	**$122,539**	**$1,769,847**
Other Costs						
Deferred Development Costs and Operating Expenditures	$52,040	$23,328	$71,724	$0	$0	$147,093
Initial Cash Balance	0	0	10,000	0	0	10,000
Financing Costs	0	61,134	86,816	94,955	111,556	354,461
Legal & Advisory Fees	0	15,000	0	0	0	15,000
Debt Service Reserve	0	0	0	0	80,865	80,865
Excess Cash Balance	0	47,213	0	0	195	47,408
Total Uses	**$79,035**	**$752,341**	**$875,789**	**$402,353**	**$315,155**	**$2,424,673**
SOURCES						
Total Project Debt	**$0**	**$1,000,000**	**$24,299**	**$242,981**	**$182,720**	**$1,450,000**
Shareholder Funds						
Initial Paid in Capital	$79,035	$0	$0	$0	$0	$79,035
Additional Paid-in Capital	0	1,986	550,148	-1,576	-185,047	365,511
Operating Cash Flow[b]	0	47,213	4,484	160,948	317,481	530,126
Total Shareholder Funds	**$79,035**	**$49,199**	**$554,632**	**$159,373**	**$132,434**	**$974,673**
Total Sources	**$79,035**	**$1,049,199**	**$578,931**	**$402,353**	**$315,155**	**$2,424,673**

Figure 3.1 – Petrozuata Uses and Sources of Funds Pre-Commercial Operation

After explaining the project, the HBS case write-up provides a complete description of the structuring of the Petrozuata project including independent engineering analysis, EPC contracts, construction guarantees, letters or credit, completion tests, the off-take contract and other features. The teaching note explains that Petrozuata was an "extremely well crafted deal" and how project finance can "create value … with skilled execution". Presumably this means the project was able to effectively manage risk by using contracts to allocate the risk to different parties. In the teaching note, project finance is defined first as "asset based financial engineering" and then as "a financing of a particular economic unit in which lender is satisfied to look initially to the cash flow of earnings of that economic unit as the sources of funds from which a loan will be repaid and to the assets of the economic unit as collateral for the loan."[20] This definition of project finance demonstrates nothing other than how finance language makes a relatively simple concept complicated.

An alternative definition of project finance can be derived from thinking about an amorous relationship that has different phases and risks. The relationship

[20] Nevitt, Peter, K.,1983, Project Financing, 4th Revised Edition (London: Euromoney Publication, 1983), p.3

project begins with a dating phase which is analogous to the development period in project finance. Here the risks of project failure are high but the expenditures are not great. No third parties are generally involved in paying for dinner dates or permitting cost. If the development proceeds, financial close is achieved where a commitment fee is made to the bank. In the relationship analogy, the engagement is agreed to after a proposal and a commitment fee is made by paying for an engagement ring. After large expenditures for construction (or a wedding ceremony and the first house), the commercial operation date occurs. After this date, risks change a lot. Now the operation of the project must generate enough money to pay back debts as a family must pay off mortgages and obligations related to children. After a few years of operation, the risks of the project may further decrease as there is some history demonstrating the project (marriage) can really work. Eventually, the project just ends (one of the people dies). Figure 3.2 illustrates phases of the Petrozuata project along with the actual and projected oil price. The graphs in Figure 3.2 demonstrates actual oil prices were dramatically above oil prices used by investors and lenders in assessing the investment.

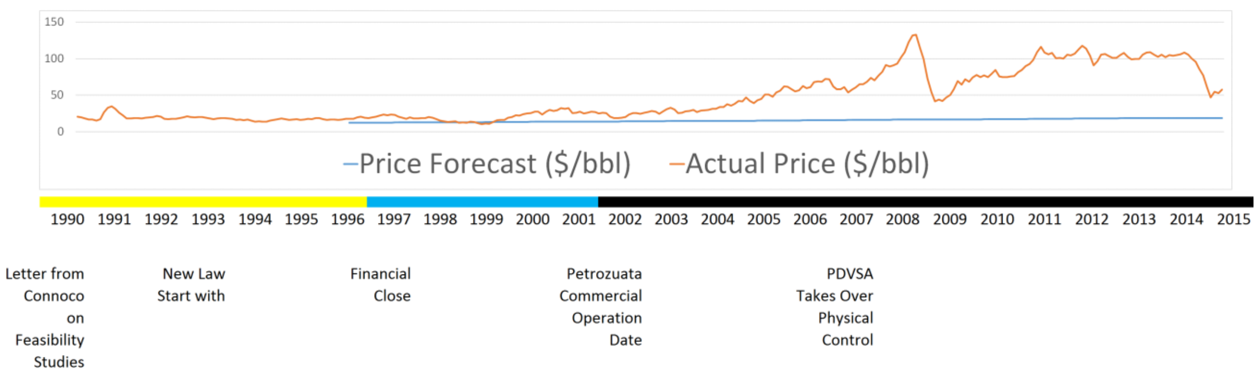


Figure 3.2 – Petrozuata Time Line with Project Finance Phases

To see why Petrozuata was touted as the deal of the decade, you can look at the sources side of the uses and sources statement presented in Figure 3.1 (the statement measures inflows and outflows from financial close to commercial operation). A large chunk of financing from debt, $1 billion of bonds, occurred just after financial close of the project the project in 1997. Development costs were financed with equity and the sponsors, Conoco and PDVSA put $550 million into the project a year later. Including the subsequent financing from banks, the percentage of debt contributed relative to the debt and equity contributed was 76%. (There are other ways to compute this number by including the operating cash flow as equity, but it can be argued that the initial operating cash flow came about because of the debt and equity funding and that the equity percentage should only include true contributions of cash.) Much of the HBS case write-up describes

issues debt financing of the project including interest rates, the way the debt was to be repaid, interest rates and covenants.

One of the most remarkable parts of the debt financing were the low credit spreads that were achieved on the project. Credit spreads compensate lenders for taking risk and are measured in basis points (100 basis points is 100%). The credit spreads above base interest rates for the bonds and the bank debt were all below 2.3%. This is far below the credit spreads that could have been achieved if PDVSA would have issued its own bonds. The spreads on the bonds were less than the spreads on the bank debt because the bonds were able to achieve an investment grade credit rating. This rating was granted even though no political risk insurance was added to the cost of the bonds or the bank debt. The spreads for bonds and maturities were:

$300 million 12-year maturity at 130 over treasuries (7.63%)
$625 million 20-year maturity at 145 over treasuries (8.22%)
$75 million 25-year bullet bonds at 160 over treasuries (8.73%)

For the bank debt, the maturities were shorter and the interest costs were somewhat higher:

$200 million 14-year maturity at 220 basis points
$250 million 12-year maturity at 208 basis points.

If the sources and uses statement paints a picture of the project during the construction phase of the project, a cash flow and debt service diagram can be made for the project after the construction period. This picture that shows the cash available for debt service and the debt service is presented in Figure 3.3. Risks for the lenders can be seen by looking at the buffer between the cash flow and the debt service as well as the buffer at the end of the debt service period. Even at a low oil price that does not exceed $18.64 in nominal terms, the project experienced a minimum debt service coverage of 2.08. When measuring the present value of the cash flows relative to the debt service called the PLCR, the coverage was 3.48. The DSCR, LLCR and the PLCR can be translated into the break even oil price through computing the percent decrease that can be accepted (these ratios and computation of the break even points are discussed in the last section of this chapter).

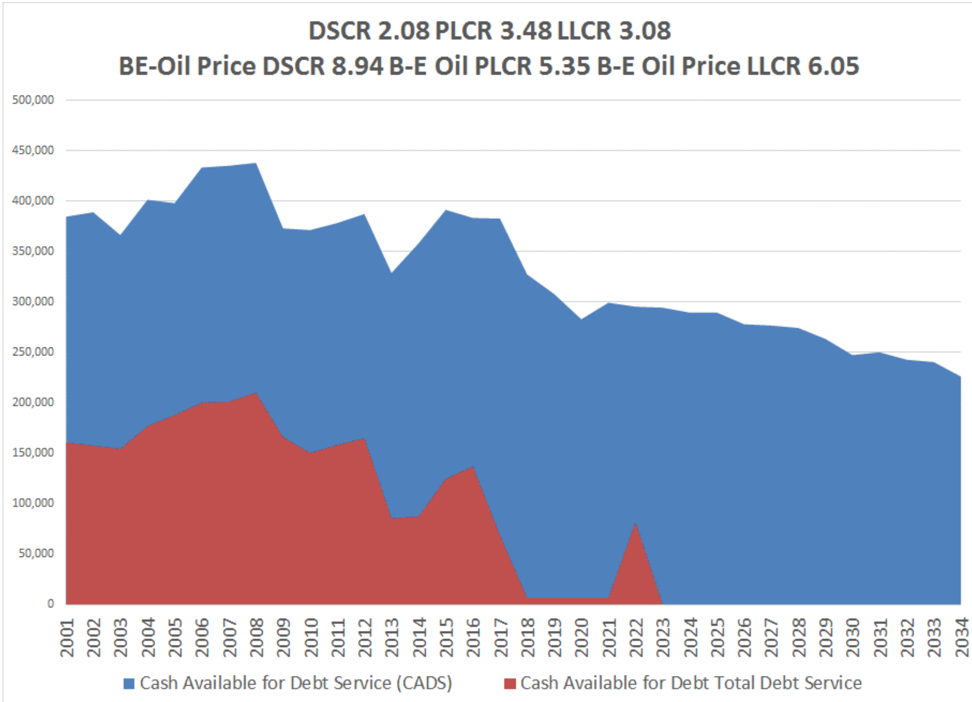


Figure 3.3 – Petrozuata Cash Flow and Debt Service Buffers Using Oil Price Estimates

With the debt structure defined, various risks can be evaluated. Ben Esty's article *Petrozuata: A Case Study in the Effective Use of Project Finance* works through different risks in the project for alternative phases. A risk matrix is presented that demonstrates the only risks taken on by creditors was the possibility of the oil price falling below $8 for long periods of time and political risk, The article by Esty and the Teaching Note discuss all sorts of ways that political risk was mitigated including: (1) the need for Conoco's expertise; (2) the inability to attract more foreign investment after a nationalization; (3) retaliatory actions by foreign governments; (4) the fact that PDVSA, a government owned entity, is a partner in the project; (5) the ability of Conoco to refine the oil that comes out of the upgrader (called syncrude); (6) use of off-shore accounts in the cash flow waterfall; and (7) the use of debt leverage. These mitigants are typical of the writing in credit memos where bankers justify to themselves that acceptance of risks is reasonable. The discussion also is used to explain why creeping expropriation through increased taxes would not occur.

To be sure, there are valuable project finance structuring lessons in the case. Without project finance, project may not have been built or would not be feasible because of a high cost of capital. With project finance, risks were put into a closed fence and were able to be quantified without worrying about a host of unknown issues associated with PDVSA that could suddenly appear. However, as

stated above problems with the project arose fairly quickly. The time line in Figure 3.4 demonstrates events that led up to the nationalization in 2007. Petrozuata's bonds were repaid, but compensation to equity holders remains a subject of bitter dispute.

Valuation Flaw 1: Begin by Understanding the Implications of the Cost Structure and Pre-tax Cash Flows

The ultimate issue in the oil industry when it comes to private investment is who gains the economic benefits – the difference between the oil price and the production cost -- for resource that is under the ground. In the U.S., people lucky enough to live above oil fields and private oil companies that explore and develop the reserves receive the economic benefits of the difference between prices and costs. By contrast, Saudi Arabia famously nationalized its industry in the 1970's, a little more than two decades after oil was discovered in 1949 largely by accident. In other countries such as Indonesia and Kasikstan, profits on oil exploration are carefully regulated through production sharing agreements. In analysis of risks and value, the first questions that should have been addressed before all of the project financing structuring analysis and cash flow waterfalls is how much economic rents economic rents were generated for foreign companies that would not be available to people in Venezuela. The Petrozuata project included a foreign investor without sharing or upside or downside risks associated with oil prices. Whether this structure makes sense or whether another structure such as hiring Conoco as a consultant should have been the first question in the case. It was not.

In all of the Petrozuata cases write-ups and other articles there is no mention of the cost of production for the project and there is no computation of the overall return on the project. Production cost of the project including a return on investment provides a basis to evaluate the economic rents accruing to investors and can be the first step in considering political risk as well as the project economics. The first valuation mistake in the case write-ups is therefore not beginning by asking basic questions involving whether a scenario with low production costs and high profits is logical and sustainable for a foreign investor. This is analogous to the point that for any investment, the starting point should be evaluation of EBITDA, capital expenditures, working capital changes and taxes. These operating cash flows form the basis for evaluating how the cash flow is later split-up. If the operating cash flows produce a rate of return below the interest rate for base case scenarios, the project should not proceed. More specifically, when the project IRR is below the all-in debt cost, the company is not generating

sufficient cash flow to cover its cost of capital. A more interesting question arises on the other side of the equation. When the project IRR is very high, questions need to be asked whether the project is too good to be true and what is so special about this project that allows it to.

To demonstrate the usefulness of measuring production costs, consider the issue of whether shale oil and gas production is viable over the long-term. Ignoring the environmental issues associated with shale gas, a fundamental question involves the real production costs of using fracking to produce oil and gas. Shale oil and gas often suggested as a big reason the U.S. was able to recover from the recession of 2008. You can look on the internet and find ranges in production cost for shale oil that vary between $40 and $100 per barrel. If the production cost of shale oil is above $100 per barrel, many of the investments may turn out to be uneconomic and the shale oil boom may be something akin to the housing bubble before the global financial crisis. On the other hand if the production cost is in the range of $40 per barrel as others suggest, then shale oil does deserve all of the hype. An estimate of production costs made by Goldman Sachs where projects are assumed to earn a return of 11% is displayed in Figure 3.4.

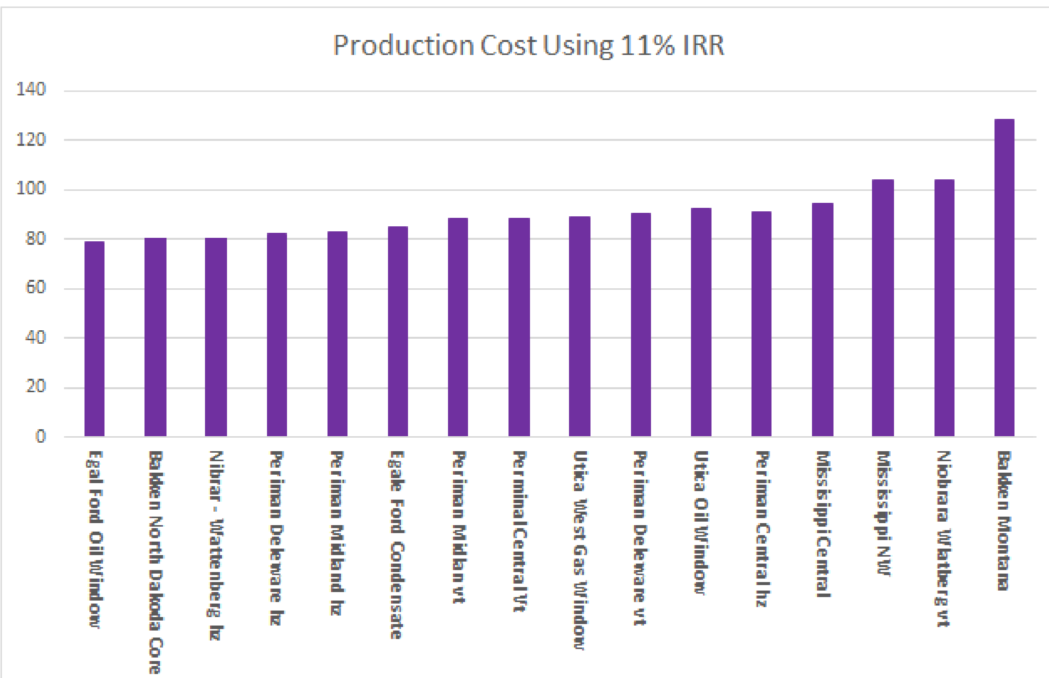


Figure 3.4 – Estimated Production Costs for Shale Oil (Goldman Sachs)

Computing production costs of shale oil challenging because of uncertainty associated with the amount of production that will be generated from capital expenditures made from drilling. The decline curve for share oil reserves is short, meaning that new wells must be continually be drilled resulting in what some have called the drilling treadmill. Further, the production generated from new wells could decline as the low hanging fruit is the first to be developed and subsequent projects are less productive. Evidence of high production cost is financial problems of some shale oil investments when the oil price was above $100 per barrel. For example, Shell oil took a $2.1 billion write-off of shale oil investments in Texas in 2013. At the time it made shale oil investments Shell expected to produce 250,000 barrels of oil per day.[21] But the company admitted "the production curve is less positive than we originally expected" and it is only producing 50,000 b/d from these properties. While there are many other examples of companies with financial problems during high oil price periods, investor presentations made by various companies suggest the cost of drilling is not very high, especially compared to deep water alternatives. The reports suggest high IRR's can be earned on drilling even when the oil price is low.

The production cost of Petrozuata can be computed from the capital costs of the upgrader, pipelines and the drilling costs for upstream facilities as well as the operation and maintenance costs and taxes. In computing the capital cost component of production costs, amounts must be levelized and converted to real currency. Cost of money, production, taxes and inflation complicate the calculation. The techniques for computing and evaluating production costs are described at length in Part 4 of this book. In addition, a video describing how to compute the costs is included on the associated website. As the mechanical calculations are documented in Part 4, details of the calculation are not repeated here. Compared to the shale oil and gas industry where the key question is the level of production, computing the cost of production for Petrozuata is a relatively straightforward process. Figure 3.5 presents the production costs using different overall costs of capital ranging between 8% and 12%.

[21] Financial Times, August 1, 2013 "Shell write down is bad news for US shale", Guy Chazanhttp //www.ft.com/cms/s/0/cf41cc36-fab2-11e2-87b9-00144feabdc0.html#ixzz3YM0hydc6

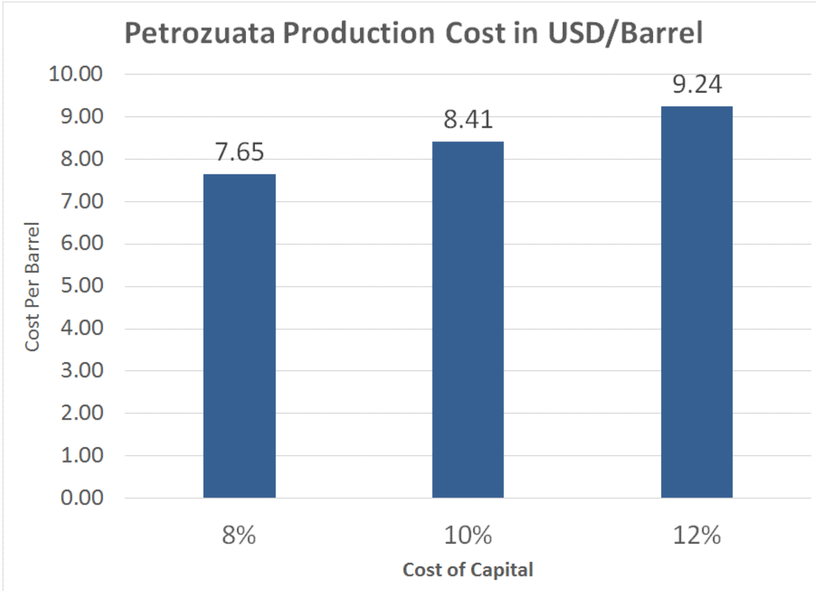


Figure 3.5 – Petrozuata Production Cost with Different Overall Cost of Capital

The fundamental issue in this case is just who gets the difference between an oil price of something like $100 per barrel and the production cost shown in Figure 3.5. One could imagine a stacked bar where the top or the bar is $100 and the space between the production cost and the production cost must go to somebody. In the Petrozuata case, using the $18 per barrel oil price, all of the money represented by the space between the oil price and the production cost goes to foreign investors. When the oil price increases above $18 per barrel, most goes to investors and some goes to the government in terms of royalty and income tax. With most of the money accruing to investors, it would be naïve to believe that ownership and sharing structure is sustainable in most countries.

In the case of Petrozuata, tax breaks were granted to the equity investors in the Orinico Belt projects meaning that less of the difference between the oil price and production cost accrues to the government than would occur in oil projects that did not receive special tax treatment. The tax breaks presumably were made because the investors maintained that the investment could not be made without the favorable treatment (nobody else had an incentive to reduce taxes). An odd argument for project finance was presented in the teaching note: "Petrozuata captures tax benefits that PDVAS cannot….[I]f PDVSA had financed the project internally, it would have been subject to a 67.7% tax rate and a 16.67% royalty rate." As PDVSA is part of the government of Venezuela, the taxes paid by PDVSA are not relevant in considering the production cost. The taxes paid by one arm of the government simply go to another arm. The only argument for maintaining the tax treatment was the government of Venezuela would be violating an earlier agreement.

Now that we know the oil price has been above $100 per barrel for long-periods of time, it is clear that the first question in the case should be, and should have been when the project was developed, is how will people who live in the country find it acceptable to give away the difference between the production cost and the oil price to a foreign investor. This potential scenario with higher oil prices suggests that the simple structure of allowing foreign firms without sharing some of the gains may have been a dangerous strategy. It is easy to laugh at Hugo Chavez and suggest that this is simply a crazy socialist, but the notion of who really should receive economic profits has little to do with Hugo Chavez. It would be present for a natural resources in any country. Figure 3.6 presents a time line that includes political events including the election of Hugo Chavez, the attempted coup, increases in the royalty rate, increases in the tax rate and the ultimate nationalization.

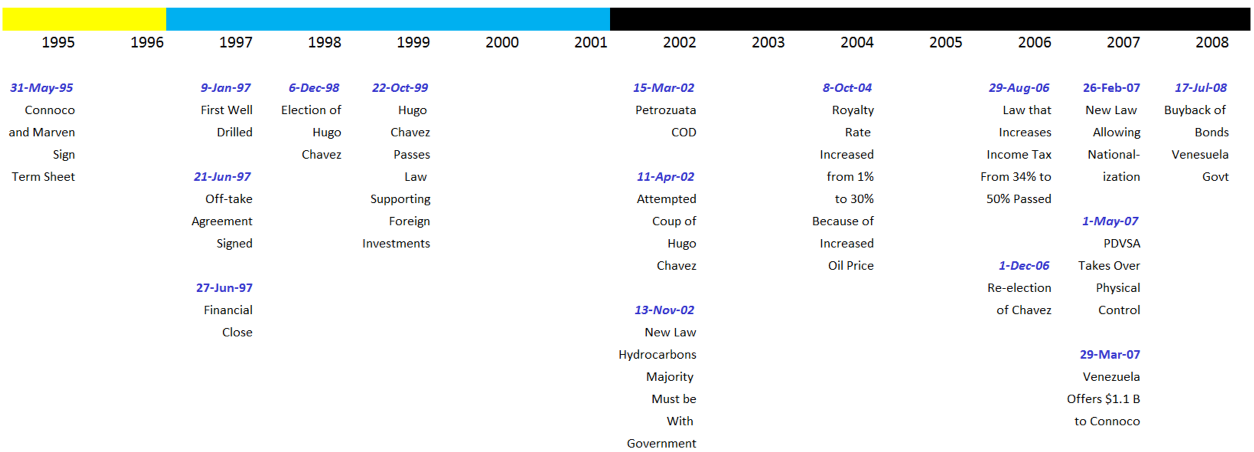


Figure 3.6 – Petrozuata Time Line with Political Events

Valuation Flaw 2: Interpreting Value of a Project Finance Investment with High IRR over Long Periods

The teaching note to the case commented that Petrozuata’s IRR for the base case is 25.6% and implied that this was a reasonable number relative to the cost of capital. The equity IRR can computed by putting the equity outflows next to the inflows in the case write-up and then applying the IRR function in excel. The Teaching Guide later proceeds to discuss a more complex approach called a quasi-market valuation (QMV). (This is nothing more than computing the present value

of prospective cash flows but it has a fancy acronym.) Difficulties in interpreting high IRR's that are measured over long-periods is the valuation problem discussed here and in particular, just how much money do projects with high IRR's provide to equity holders. When IRR's are above double digits and cash flow is earned over long periods, the statistics quickly become all but meaningless. The cash to investors when the IRR is high becomes enormous simply because of the mathematics of compound interest and the IRR indicator does not show just how much is being earned. Alternatives to the IRR that measure how much is generated relative to other investments that could be made with the money that is injected into the project.

An alternative to computing the IRR that would should be immediately dismissed by any MBA student is computing the payback period. At the very low oil prices assumed in the case, the investment made in 1998 and that enters service in 2000 is fully paid back after 3 years of operation in 2002. For people with a sophisticated financial background, this payback analysis would be immediately dismissed because it does not account for cost of money or risk. But it may tell more about the profitability of the project than the IRR. If your money is paid back in a couple of years at a low oil price and the rest is upside, the investment is very profitable. You don't need much more fancy analysis.

Over the past couple of decades managers have become more and more enamored with the equity IRR. In a single statistic you can summarize the entire profitability of a project and compare returns across different projects. For a leveraged buyout that has a single cash outflow and a single cash outflow, the IRR is simply a measure of the compound growth rate on the investment and there is no ambiguity about the statistic. Conoco has asked for $30 billion from the country of Venezuela as compensation for its investment in the arbitration process. When this cash inflow is compared to half of the $500 million equity investment made in 1998 shown in the sources and uses of funds statement, the IRR calculation can be made on your I-phone. You divide $30 billion by $250 million and then raise the result to the number of years between 2015 and 1998 minus 1. This number that does not account for cash flow earned by Conoco from 1998 through 2007 results in a CAGR or IRR of 32.5%. It demonstrates just how much is generated from a high IRR. If the IRR were 10% and the investment were $250 million, the one-time cash flow at the end of the period would be $1.275 billion instead of $30 billion. The example demonstrates that numbers are dramatic and become so big that they are practically meaningless when IRR's are high. The mathematics of why high IRR's are not useful in measuring value are discussed in Chapter ___ of Part 3.

When the cash flows occur in intervening periods instead of all at the end of the project, interpretation of the IRR statistic becomes a lot more difficult. A

question that was raised by a lawyer a few years ago was what all this business about IRR is anyway. The question is not so easy to answer, especially when the IRR is high and there are continuing cash flows. With high cash flows generated soon after the investment is made, the IRR is high even if no future cash flow goes into the pocket of equity holders. In these cases the future cash flows seem to make no difference at all in the IRR calculation. For the Petrozuata data presented in the HBS case where nominal oil prices do not increase above $18.64 per barrel more cash flow accrues to the project at the end of the project than at the beginning of the project in the numbers presented in the HBS case. Even though out year cash flows are high, the IRR does not change with future cash flows. Figure 3.5 displays the IRR where cash flows after various dates are ignored and assumed not to be given to equity investors after various end dates. The graph shows the IRR has virtually no change after year 2009. However, nominal cash flows after 2009 are even more than the cash flows before 2009. In business school you can try to explain away why this is reasonable. The result does not make sense. Chapter ___ of Part 3 explains the mathematics of the IRR and why results like this that do not make sense occur. A video on the associated website www.edbodmer.com demonstrates how to create this analysis from data presented in the HBS case.

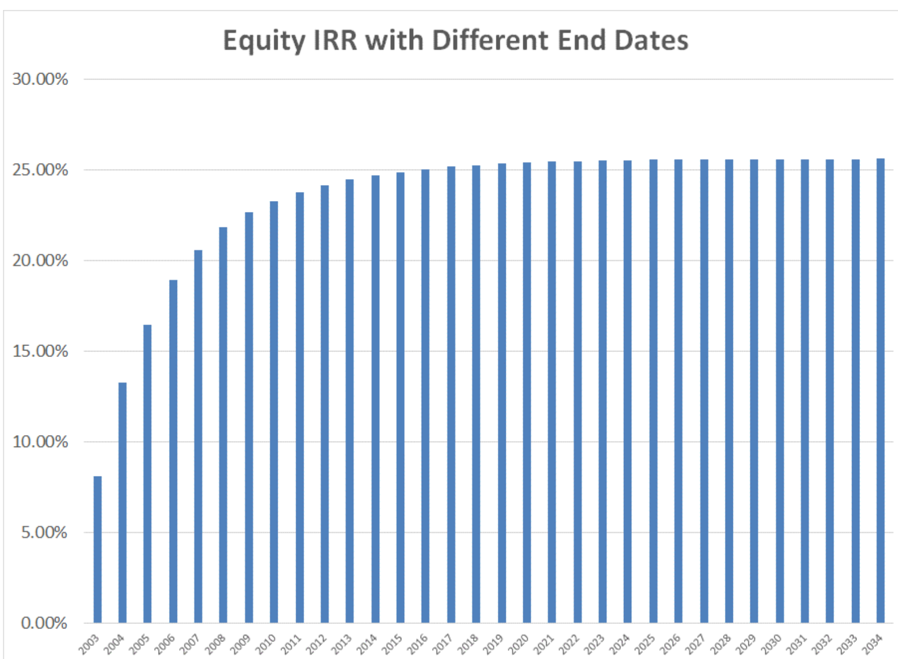


Figure 3.7 – Petrozuata Equity IRR for Different Time Periods

After the project begins operation, the risk changes a lot, just like the risk of a relationship failure changes after the wedding date. The remaining risk other

than political risk for Petrozuata was the oil price. In theory the oil price could be hedged with a forward contract reducing the risk to virtually a risk free project. The project could then be sold to another company and where the buying company should not have a return much higher than the risk free rate. Using futures markets together with low discount rates is discussed in the arbitrage pricing chapter in Part 2. Even if the risk free rate is not used by a prospective buyer, the required return should be a lot lower after the construction period. Assuming the project would be sold where the new buyer would accept a series of lower returns as the risk is resolved produces a maximum IRR of 60% rather than the 25.6% mentioned at the beginning of the section. Figure 3.8 shows different IRR's that result from different sale dates and buyer discount rates. Reasons for the IRR's being different with different sale dates is explained in Part 3. The point of Figure 3.8 is to demonstrate that when it comes to IRR's you can take your pick. Figure 3.8 also confirms that when the IRR is very high, the number in ambiguous as the variation in IRR's is greater.

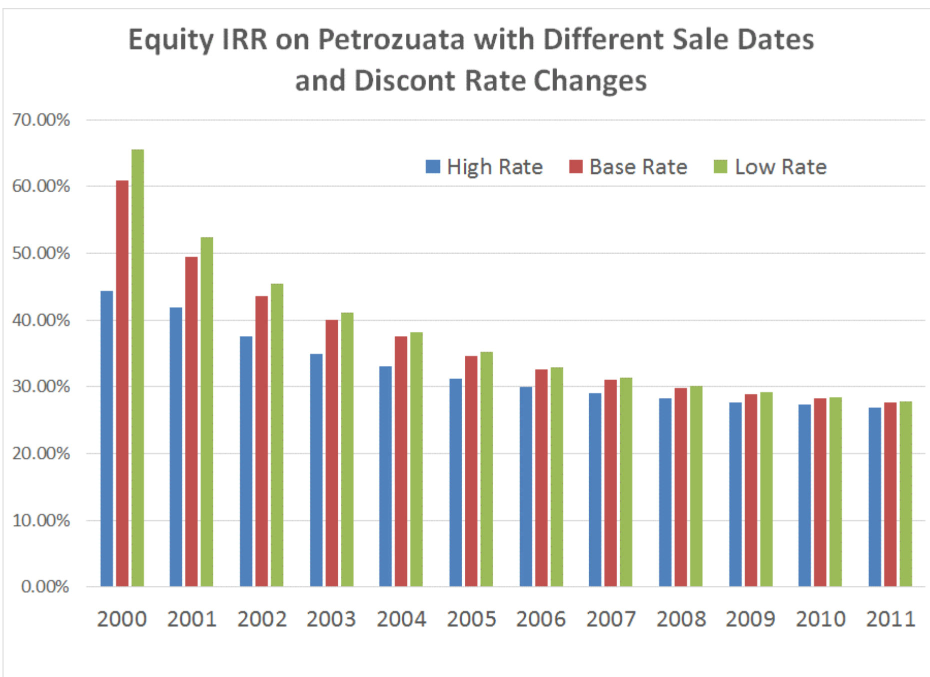


Figure 3.8 – Petrozuata Equity IRR Accounting for Changing Risk in Different Scenarios

To see what an IRR of 25% means, you can compare the amount of money that you make from the 25% IRR with the return you would make by investing at the risk free rate. The additional money you make above the risk free rate is the risk premium. This risk premium you earn can be discounted to the date of the

investment and compared to the size of the investment. You can think of the risk premium measured in this way as follows. Assume that you make the equity investment of $700 million in a risk free investment (the amount of the investment including accumulated interest). Then, you think about either the amount of money you make from the risk free investment or alternatively an investment in Petrozuata. With the Petrozuata investment, you will get the risk free investment as long as things work out, but you ask to be paid for taking the added risk. For Petrozuata, relative to the equity investment of about $700 million made by Conoco, this risk premium you earn for taking risk is $2.6 billion or 172% more than the initial investment. Unlike the IRR, when the risk premium is measured in this way, cash flows at the end of the project make a big difference. The earned risk premium in absolute terms and relative to the equity investment is shown in Figure 3.9. Technical details of computing the risk premium are described in Chapter __ of Part 3 and a video describing the process is explained on the website www.edbodmer.com.

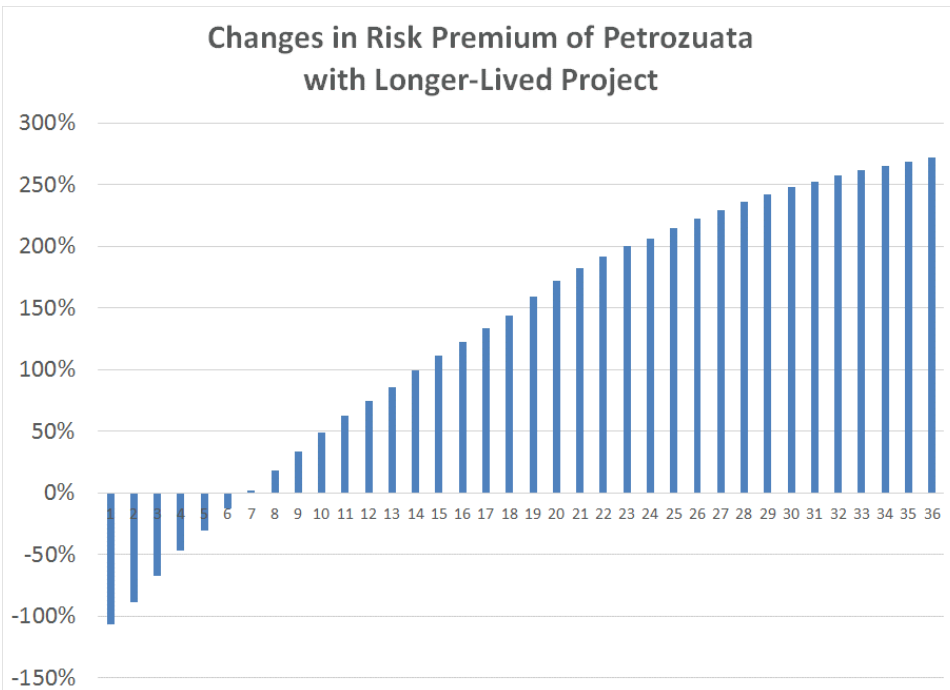


Figure 3.9 – Petrozuata Equity Risk Premium Earned as Percentage of Investment for Different Horizons

Figure 3.9 demonstrates that even though an IRR of 25% earned over 35 years may not sound like it is that high, it is in fact enormous. Downside risks of the project other than the political risk were not very high, particularly given the nominal oil price assumption of a little more than $18.6 per barrel over extending to the year 2035. You can think of the risk premium shown in Figure 3.9 like the

additional salary you would need if you accepted a lower fixed salary plus a variable bonus for an exciting job as compared to a purely fixed salary for a boring job. If there is very little chance that your salary will be less than the fixed amount, you would presumably not need that much more to accept the variability that comes along with the alternative bonus structure. Applying this analogy to Petrozuata with the low oil price assumption would mean that your salary with the variable structure would be many multiples of your base salary. If your base salary was 100,000 for the boring job, the salary for accepting the job with risk that the oil price will be below $18 per barrel in nominal terms will be 372,000. The real question if your bonus is extremely high is whether you are too greedy and whether this high salary can be sustained. This analogous to accepting political risk that the high returns can be continued in the Petrozuata case. The valuation lesson is that the IRR is not a reasonable measure of economic profit when the IRR numbers are big. As an investor, you can ask for this type of high IRR, but it is very difficult to earn this kind of money over a long period without taking very big risks.

Valuation Flaw 3: Expecting to Earn High Returns on Off-Shore Investments and Taking Political Risk

Estimated cost of equity for the project is discussed on the second to last page of the HBS case write-up. The total cost of equity is computed from an un-levered and re-levered beta of refineries, a premium for start-up companies of 2.1%, an equity risk premium of 7% and a country risk premium of 6.67%. Adding these numbers to a risk free rate of 5.6% yields a minimum required return on equity of a whopping 20.95%. -- 5.6% + .94 x 7% + 2.1% + 6.67%. In considering various different issues in the Petrozuata case, most people probably do not pay much attention this 21% number. Similarly, when working with real transactions and seeing discussion of ungeared beta, the equity risk premium, country risk premiums and a start-up premium, managers generally gloss over the numbers and ask about the projected IRR. But the Teaching Guide discusses the cost of capital at length including what sample of companies to use in estimating beta and even adjusting the beta through dividing the volatility of the Venezuelan market by the volatility of the U.S. market. The entire subject of Part 2 involves addressing flaws in attempting to measure the true minimum return investors need to make an investment and demonstrates how irrelevant the whole CAPM process is, before making an irrelevant adjustments for relative volatility. Theoretical problems with computing beta, estimating the equity market premium, making

arbitrary additions for things like start-up companies and distortions from un-levering and re-levering betas are all addressed in Part 2.

The idea that an equity cost of capital of 21% could be appropriate demonstrates nothing other than, when it comes to cost of capital, you can use the CAPM to come up with any number that you want. Without going into details of things like the equity market risk premium, the absurdity of such a high number can be demonstrated from a macroeconomic perspective. If typical investors really need to earn a return 21% before they will make an investment (the implication of a beta close to 1.0 in Venezuela) then it follows that corporate profits will also need to grow by 21% to promote new investments. This means that unless the whole economy grows by 21% or more, somebody in the economy other than investors would have to accept lower income to maintain new investment with the required return. To demonstrate this, pretend the economy only consists of workers and investors, and the economy grows on a nominal basis by 8%. If investors take 21% of the growth out of the economy through profits, it can only mean that other segments must be growing at a rate of less than 8%. The income dispersion would get a worse and worse in this scenario.

The flaw in valuation with respect to using high cost of capital estimates has particularly serious repercussions when a high country risk premium is applied. In the case of Petrozuata the 6.67% premium is used to compensate for potential country risk associated with nationalization would aggravate the political risk and create a self-fulfilling prophecy as illustrated in Figure 3.10. If the political risk premium is high, this means investors will insist on taking a big piece of the difference between the resource value and the production cost as discussed earlier. But people who live in the country will soon figure out how much money is flowing out of the country and they will make all sorts of accusations about corruption and injustice. These accusations increase political risk. A viscous circle is created whereby the country risk premium itself increases political risk which in turn prompts and even higher risk premium and then results in even more dissatisfaction with the foreign investor. A diagram of this process is shown on Figure 3.10.

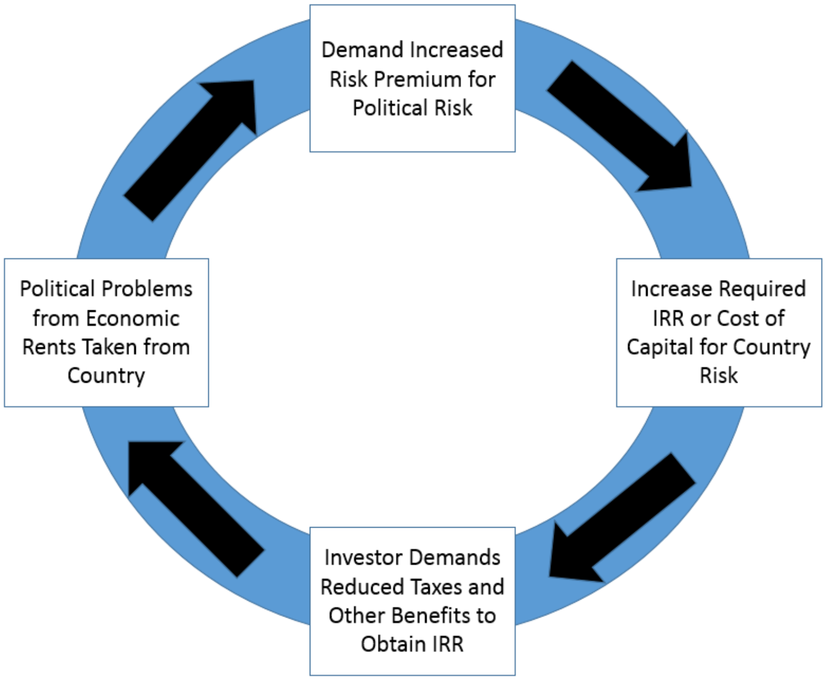


Figure 3.10 – Viscous Circle of Political Risk

Problems in demanding an IRR that includes a high country risk premium can be demonstrated with a hypothetical cash flow analysis using the 6.67% risk premium used in the Petrozuata case write-up. To demonstrate just how high this number is, you can begin by computing the required cash flow to generate an IRR without the risk premium, say 13%. This can be established with a simple goal seek function. Next, the assumed the same investment, but compute the increased cash flow required to generate the higher IRR that includes risk premium.

These higher cash flows can then be reduced by the probability of expropriation and the loss once and expropriation has occurred (like the probability of loss on and investment and the loss given default). The cash flow after probability of expropriation for the country can be derived through multiplying the higher cash flow that is sufficient to produce an IRR with a risk premium by the probability of expropriation less the recovery assumption. Finally, the implied probability of loss can be established through backing into the probability of default that yields the same IRR as the amount that would be adequate without the political risk. Technical details of implied calculation of risk premium are described in Chapter __ or Part 3. Figure 3.11 demonstrates results of the implied probability of expropriation analysis with different assumed expropriation dates and different assumed recovery percentages. The extremely high probabilities show that slapping on high risk premiums on the required rate of return produces nonsensical results.

Probability of Expropriation Table

		Loss, Given Expropriation				
		20%	40%	60%	80%	100%
	1	91%	78%	65%	52%	39%
Year of	3	102%	89%	75%	62%	49%
Expropriation	5	115%	102%	89%	75%	62%
	7	132%	119%	105%	92%	78%
	9	154%	140%	127%	113%	99%

Figure 3.11 – Implied Probability of Expropriation with Different Recovery Rates and Expropriation Timing

The issue of risk premiums for political risk can be evaluated in the Petrozuata case. As shown in Figure 3.2, the project was nationalized after only a few years of operation. In the intervening period, royalty rates and income tax rates on the project increased dramatically. The royalty rate increased from 1% to 30% and the income tax rate increased from 35% to 67%. This can be called creeping nationalization. But over the same period, the oil price was much higher than the amount forecast. Even with the increased taxes, the IRR was higher than forecast because of the oil prices. When looking at Figure 3.4, the IRR increases rapidly and after only a few years obtains a level of 20%. This means that Conoco probably did receive a hither IRR than could have been earned on other projects even though it was nationalized. Finally, Conoco will receive some compensation for its investment as a result of the arbitration proceedings. Venezuela's initial offer was to pay back the book value of Conoco's investment while Conoco is asking for $30 billion. After Conoco receives something in between it will have performed a lot better than investments that would have been made in countries that do not have political risk.

Valuation Issue 4: Upside Potential, Downside Risk and Inappropriate Use of Monte Carlo

The Teaching Guide for the Petrozuata case included a Monte Carlo analysis of the project with respect to the oil price. It suggested using Crystal Ball and applying a 20% volatility statistic to the percent change in the oil price. Using the Monte Carlo simulation a fancy analysis established a very high probability of default of about 30%. The appendix to the teaching note presented a graph like that shown in Figure 3.10 with different oil price projections and also a distribution analysis replicated in Figure 3.11 which can be used to derive the

default probability. Most of the projections shown on the graph in Figure 3.10 resulted in nominal prices below $10 per barrel in 2035. Outputs presented in the simulation analysis include quasi market value and the debt service coverage ratio ("DSCR"). This seemingly sophisticated analysis developed a probability distribution for the DSCR from which a probability of below 1.0 is equated to the probability of default. Figure 3.11 which uses the PLCR instead of the DSCR shows that if the Monte Carlo approach suggested by the Teaching Guide is used, there is an unacceptable probability of loss from the oil price of 24%. All of this analysis that is apparently taught to business school students is utterly meaningless. It is highly doubtful that any of the actual analysis of debt and/or equity value of the actual transaction relied in any way at all on Monte Carlo, particularly the kind on analysis presented in the teaching note. Apparently, business school students are taught how to make things that are relatively simple look sophisticated and confusing.

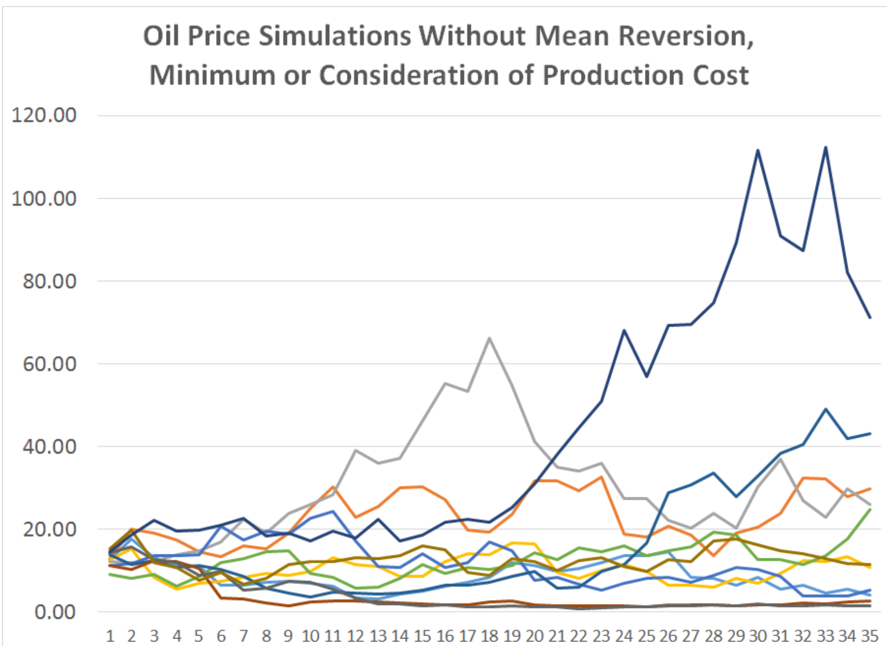


Figure 3.12 – Monte Carlo Simulation without Mean Reversion to Production Cost and Without Minimum Boundary

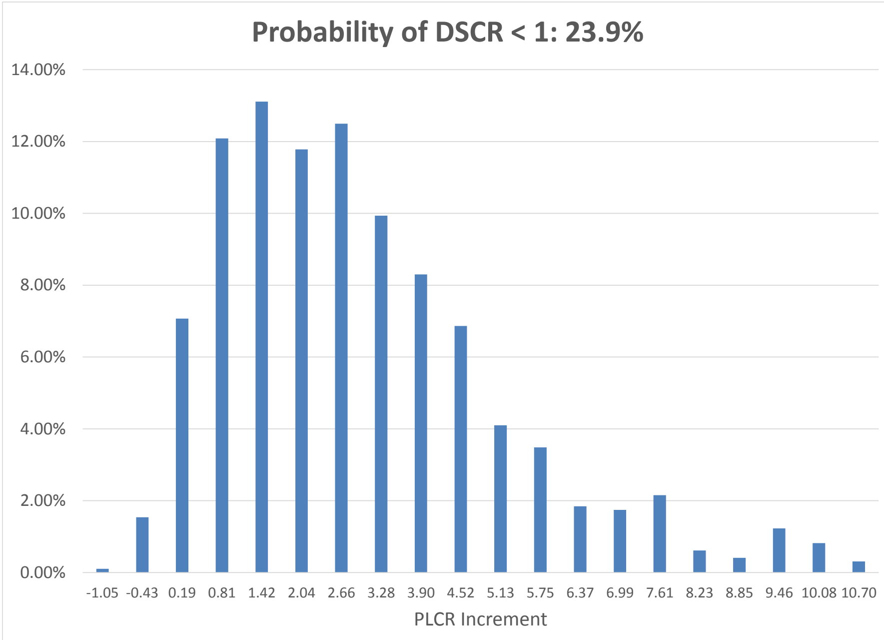


Figure 3.13 – Probability Distribution of PLCR from Monte Carlo Simulation without Mean Reversion to Production Cost and Without Minimum Boundary

The only useful thing to discuss with respect to the Teaching Guide is how this Monte Carlo analysis that produces such sophisticated looking analysis does not produce any useful results unless the underlying production costs are carefully evaluated in creating time series. The Monte Carlo analysis suggested by the HBS teaching guide does demonstrates the danger of becoming impressed with seemingly sophisticated analysis (that is really quite basic). It also demonstrates that unless the analysis carefully evaluates long-run production cost, it does not provide any real answers in terms of value or risk. Some of the issues about how just faulty Monte Carlo analysis is include: (1) demonstrating that probability of default and loss given default can be measured more easily and objectively by break-even analysis than by simulation; (2) showing that you do not need to add any costly add-in into your computer to perform a simulation -- Monte Carlo analysis can be created with a very simple macro; and, (3) confirming that if the production cost and mean reversion is not included in a time series analysis, the Monte Carlo produces a series of irrelevant random numbers.

In evaluating the probability of default, instead of using Monte Carlo simulation, you can simply perform a break-even analysis and then evaluate how low the oil price can go until the loan cannot be repaid. With this type of break-even analysis you could then make some kind of judgment as to the probability associated with the price falling below the break-even level. This would be an approximate assessment of the probability of default. One of the problems with the manner in which analysis from the Teaching Guide applied the probability of default was by only evaluating the DSCR. If the DSCR falls below 1.0 times in

one single year, this is certainly bad news. Cash flow is not sufficient to pay off the debt for that year and if there is no reserve account and/or provision to defer principal payments, a money default will occur. But this default has very little to do with the ability to ultimately pay off the loan. Figure 3.3 demonstrated that there was a whole lot of space between the cash flow and the debt service at end of the project (this graph tells you a lot more about the project than a beautiful frequency distribution graph). The ability to repay the loan over its life can be better measured by a ratio called the project life coverage ratio ("PLCR") which measures the value of the cash flow discounted at the debt rate divided by the size of the loan.

PLCR = NPV(Loan Rate, Cash Flow)/NPV(Loan Rate, Cash Flow), or

PLCR = NPV(Loan Rate, Cash Flow)/Loan Amount

When the DSCR has a value of 1.5, the cash flow can decrease by .5/1.50 or 33%. If the PLCR for the same project is 1.8, the cash flow over the life of the project can fall by .8/1.8 or 44%. For a PLCR of 2.0, the percent decrease in cash flow before the loan defaults is ½ or 50%. The loan life coverage ratio ("LLCR") is similar to the PLCR except the cash flow is truncated over the life of the loan. Figure 3.3 shows that break-even oil price using the DSCR is $8.94 per barrel. This is computed by finding the oil price in the period with the lowest DSCR which is 2.08. That oil price is reduced by 1.08/2.08 or 52% without including tax effects. Using the PLCR, the oil price can fall to $5.35/barrel in nominal terms. This means the oil price would not only have to be $5.35/barrel for one year, it would have to be at that level over the life of the project. Suggesting that there is a positive probability of the nominal oil price being $5.35 per barrel is not plausible. This is far below the short-term marginal cost in most places of the world and nowhere close to the long-term marginal cost required to promote new investment. The implication of the teaching note that the probability of default is somewhere around 30% is unreasonable. The transaction can be much more easily understood by computing a couple or ratios than by creating fancy looking simulations.

Apparently, students at business school are encouraged to create Monte Carlo analysis and then bring these seemingly innovative ideas to real transactions. It all looks elegant and sophisticated with frequency graphs, thousands of simulations, time series equations and cumulative probability calculations. The Teaching Guide suggests that you need to go out and buy an add in program for your excel to do this. Techniques to construct Monte Carlo are described in Part 5 demonstrate that the mechanical process is in fact quite simple. Discussion in this final part of the book demonstrates that creating a simulation once you have a financial model and once you understand the underlying production costs does not require any additional software other than a basic excel sheet. All you need is to write a macro with a couple lines of code. An accompanying video demonstrate

that the results produced in the Teaching Note can be replicated in about ½ an hour.

If Monte Carlo simulation is to be applied to the Petrozuata case, it can be used to demonstrate the importance of incorporating production costs and mean reversion into the process. When analyzing the production cost of oil, the low oil prices in the 1990's were probably reasonably close to short-term production costs. With hindsight we know there was a lot more upside price potential than downside risk from the perspective of oil production. Figure 3.12 demonstrates estimated production costs estimated by the IEA in 2010.[22] Use of this type of supply curve is explained in detail in Part 4 of the book. By inspecting the graph in Figure 3.14 and incorporating the level of demand, the production cost of oil on the margin is somewhere between $50/barrel and $80/barrel. Assumption that the price could remain below at $18/barrel in nominal terms in a base case and that the price could fall below $5 per barrel for long periods of time is not consistent with any reasonable analysis of long-term production costs. For these low oil price scenarios to occur, demand in the world would have to be so low that no new wells would be drilled and the only production that would occur would be from low marginal cost wells in places like the Middle East.

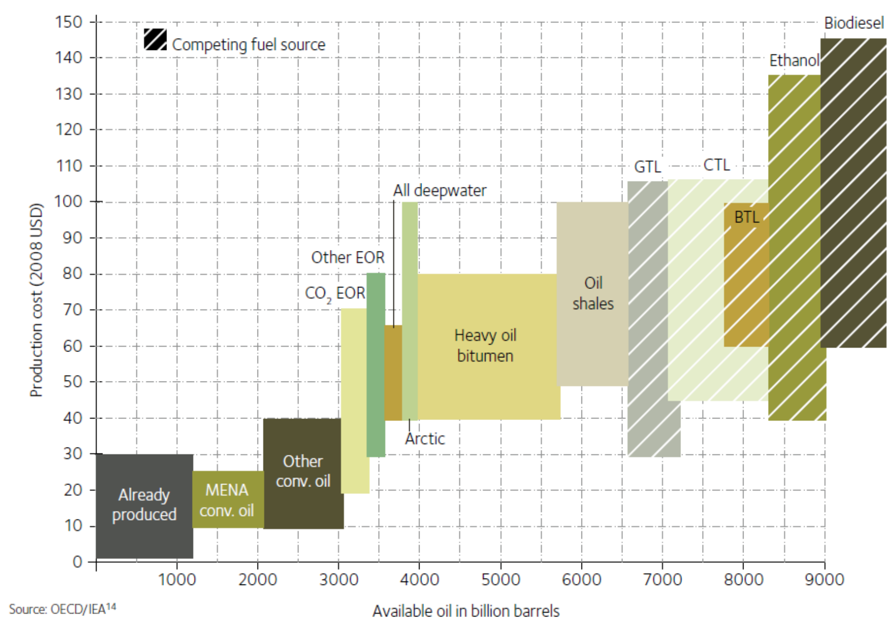
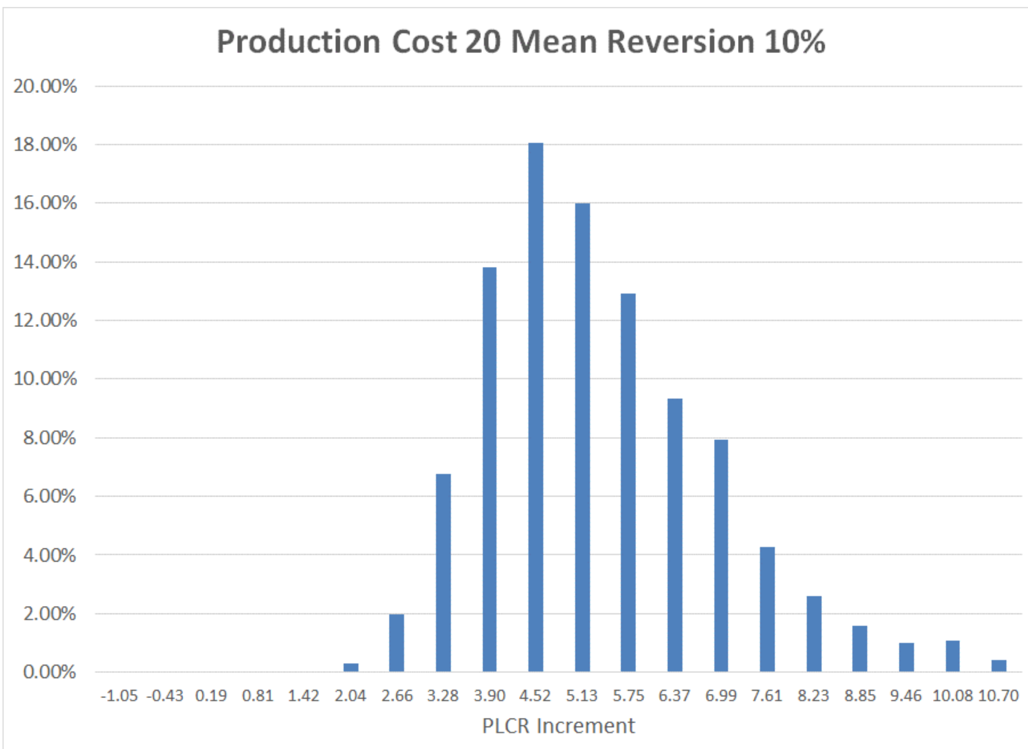


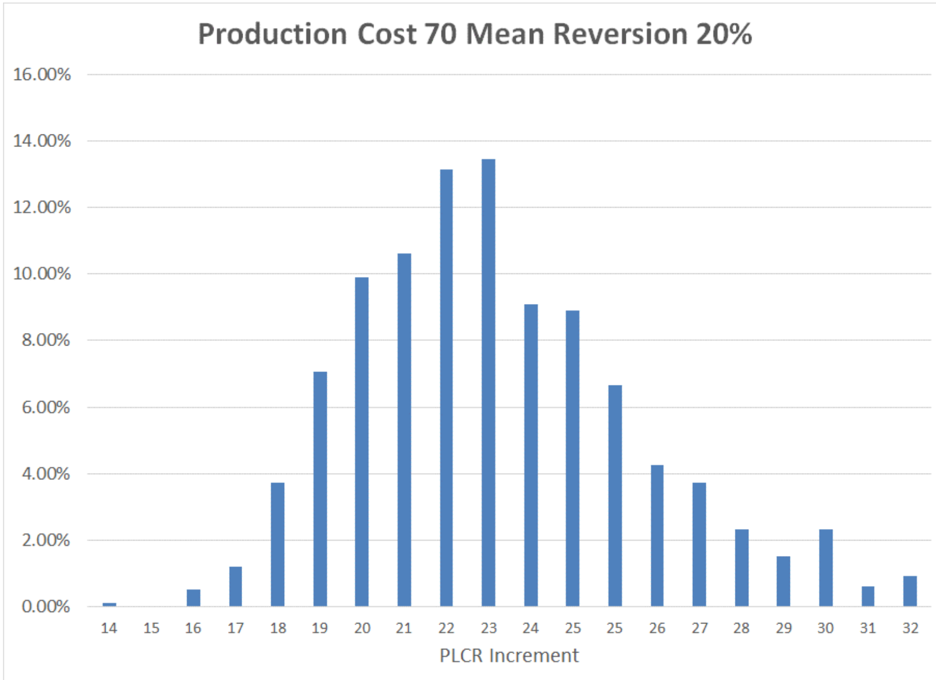
Figure 3.14 – Estimated Production Cost Curve for Oil in 2010

To demonstrate the importance of mean reversion and mean reversion in the Monte Carlo process, the process from the Teaching Guide is compared to use

[22] 14 IEA Flyer for Resources to Reserves 2010, www.iea.org/papers/2010/Flyer_RtoR2010.pdf

of mean reversion to production costs with alternative estimates of production costs. If a very low production cost of $20 per barrel is assumed along with a very low mean reversion rate of 10%, the probability of loss falls to zero. This is demonstrated with the distribution graph in Figure 3.15. With a higher production cost of $50/barrel and a mean reversion of .2, the aggregate debt service coverage ranges between 14 and 32, nowhere near the level of 1.0 that defines default, as shown in Figure 3.16. Technical details for making the calculations are discussed in Part 5 and in an accompanying video. Once the Monte Carlo is corrected for the long-run production costs, mean reversion and short-term marginal costs, the probability of loss is just about zero.




Production Cost 70 Mean Reversion 20%
16.00%
14.00%
12.00%
10.00%
8.00%
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PLCR Increment

Chapter 4

First Solar Case – Competitive Pressure, Growth and Rate of Return

Conceptual Valuation Errors Made in the First Solar Case

In describing various bungled valuation analyses, a mixture of corporate and project finance cases are used to demonstrate similarities and differences in valuation errors made in assessing all sorts of investments. The First Solar case discussed in this chapter involves valuation issues in corporate finance in contrast project finance which was used in the Petrozuata case. At the time the case was written in 2010, the company was one of largest solar panel producers in the world. First Solar's stock price had experienced a large decline after the Lehman collapse in 2008-2009 and management was considering new strategies after growth prospects for the sale of panels was dimming in Europe. The primary strategic initiative involved was to use First Solar's manufacturing skills in order to become vertically integrated, meaning that First Solar would develop, construct, finance and operate projects over their lifetime as well as continuing to manufacture panels. Despite very positive comments about the company made in the case write-up, the new strategy did not work. In a couple of years after 2010 prices of solar equipment plummeted; First Solar's stock price did not recover, but instead declined by another 80%. The company took large write-offs were for restructuring; goodwill associated with companies acquired to enter into the development business was all impaired; and, the touted top management was replaced.

The basis for discussion of the case discussion is a write-up by Stanford University titled "First Solar, Inc. in 2010".[23] A similar case was published in 2009 by HBS that discussed NanoSolar, a company that manufactured panels using the same technology as First Solar called thin film and was experiencing the

[23] Hallmon, Morgan, Siegel, Robert and Burgelman, Robert "*First Solar, Inc. In 2010*", 10/01/10, by the Board of Trustees of the Leland Stanford Junior University.

same type of challenges.[24] Both of these cases provide a general background on solar power as well as discussion of corporate strategy and finance. Additional sources of information for the discussion of First Solar in this chapter include a series of ValueLine reports for the company that illustrate how investment analysts may compute equity value as well as First Solar annual reports to shareholders. As with the HBS cases, the Stanford First Solar case is very complementary of management. Some of the laudatory phrases used in the case write-up include: "the remarkable achievements of the exceptional people…", "the industry leader…", "…accomplishments had indeed been impressive", "…prowess in manufacturing", and, "financial performance had been impressive..." The First Solar case as well as the HBS NanoSolar case even include resumes of key management in an appendix to the case write-up. Nanosolar, the subject of the HBS write-up, experienced a worse fate than First Solar. Nanosolar stopped its operations and lost just about all of the money invested by its shareholders. By February of 2013 Nanosolar had laid-off 75% of its work force and it began auctioning off its equipment in August of 2013.

The primary issue in the case write-up involves a new management strategy at First Solar in response to changes in the industry. The implicit suggestion is that the company could maintain its shareholder value by entering the development, construction and operation segments of the industry and leveraging its manufacturing process. The thin film production was asserted to be superior to competing polysilicon technologies. To implement the strategy, First Solar paid top dollar for a series of development companies that were in various segments of the downstream business. From a valuation perspective, the question is whether the fall in the equity value of First Solar that happened after 2010 was predictable and whether basic mistakes were made by investment analysts in gauging the fundamental value of First Solar. Analysis of financial statements and the structure of the solar panel manufacturing industry implies that there were indeed many conceptual valuation errors in evaluating First Solar as well as the entire solar manufacturing industry. Some of these errors discussed in the chapter include:

- Not understanding competitive pressures when making valuations that assume high returns can be earned along with high growth in commodity industries.
- Assuming that economic rents generated from government subsidies can be replaced by high returns from de-regulated markets.
- Not considering long-term prospective return as well as growth when projecting valuation multiples such as the P/E ratio and the EV/EBITDA ratio.

[24] Steenburgh, Thomas J. and Wagonfeld, Alison, "Nanosolar, Inc." OCTOBER 15, 2009, Copyright © 2009 President and Fellows of Harvard College.

- Failure to include implications of high price to book ratios when making valuations.
- Accepting potentially overconfident management beliefs that it can change its strategy and maintain high returns when it enters new businesses.
- Inappropriately using beta to measure cost of capital in valuing shares

Synopsis of the First Solar Case

As a context for understanding valuation of First Solar and other companies that experienced difficulties after 2010, it is instructive to understand the difference between corporate finance and project finance. The way you can think about corporate finance in contrast to project finance is to think about the amorous relationship analogy discussed in Chapter 3 that represented project finance as distinguished from prospects of a family or a city that are analogous to corporate finance. The amorous relationship presented as an analogy to project finance had a defined beginning, when the first development expenditures (or money for dinner dates) was made. In the case of a city, a family or a corporation, such a beginning is not so easy to identify. The city of Detroit began at some time when Native Americans inhabited the area and BMW Corporation also began a long time ago as did your family. Whereas the amorous relationship or project finance has no history, the corporation does have a history. In studying the prospects for your family or the City of Detroit it would be a big mistake not to begin by understand its history. For a corporation, the history can be understood by examining financial statements and making some sort of statistical analysis of the numbers. When projecting the future for your family and potential ups and downs it may experience, you must also understand the strengths and weaknesses of different children, parents and grandparents as well as the external environment in which the family lives. As the family, the city and the corporation does not have a definitive end, the future prospects cannot be evaluated over the entire remaining life of the entity. This is unlike the project finance where the assessment of the project success ends when the relationship is ends, as all do. This little comparison is intended to point out that in corporate finance you must study history and come up with some way to value an indefinite life.

First Solar's roots and history were in production of automotive glass in Toledo Ohio in the 1980's. It began large scale solar panel operations in 1999 to construct photovolatatic ("PV") panels using thin film technology that had a base of glass upon which a special chemical that was a semiconductor -- cadmium telluride ("CdTe") – was coated. The company reached profitability and went public in 2006. At the time of the case write-up in 2010, First Solar was not the only thin film manufacturer, but it was considered the industry benchmark for this

type of manufacturing process. After the global financial crisis in 2008, the solar manufacturing industry began having some difficulties as European countries which had been the drivers of solar power reduced subsidies and as debt financing for solar power projects became more difficult. Figure 4.1 demonstrates that from 2008 to 2010, First Solar's stock price had fell more than half after the Lehman collapse. But this decline was subsequent to a meteoric rise providing investors who bought the stock in 2006 with 12 times their investment.[25] Relative to the stock price at the IPO date, the current price was still six times as high.

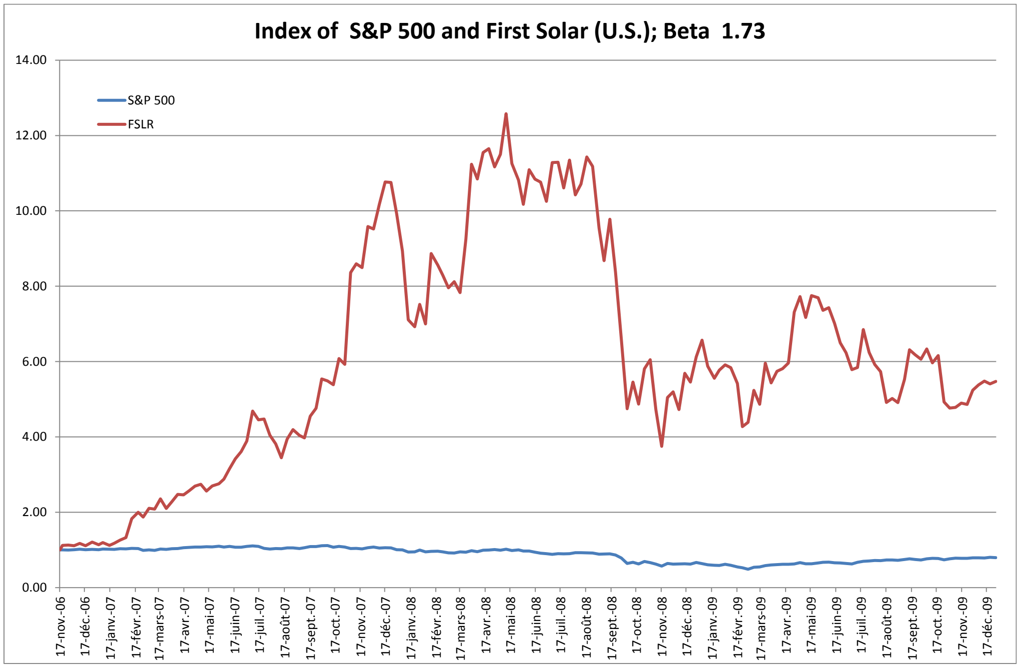


Figure 4.1 – First Solar Stock Price from IPO in 2006 Until 2010

In addition to discussing First Solar's strategy, the case write-up includes a history of the solar power industry that describes the panel (or cell) production process; subsidy and pricing schemes (feed-in tariffs, PPA agreements, capital subsidies and renewable energy credits); grid parity possibility meaning the point at which solar power can compete with retail and wholesale power rates; balance of system costs that include inverters, wiring, labor, racks and engineering. The case write-up compares the thin-film production process to the more common polysilcion technology and the solar value chain, as well as management strategy in the face of a changing environment.

Before 2008, companies in the solar manufacturing industry seemed to be an attractive investment and First Solar was surely one of the premier companies.

[25] This graph as well as other stock price graphs are made from files that can be found on the website www.edbodmer.com.

The solar manufacturing companies were earning high returns and growing at very quickly. Even though solar power represents a very small portion of overall electricity production, it had been high growth industry. The problem was that growth of the industry had been driven by subsidies as solar power could not compete with the price of electricity sold in wholesale markets. Government policies involving the subsidy structure in Germany did arguably lead to a revolution in the solar industry and it can be used as an example of effective government policy. Germany had offered a highly subsidized tariff for solar production when it started its program in 2004 meaning that money received from "feeding-in" solar power to the grid was almost 10 times the price of wholesale power. This high feed-in tariff was designed to spur the industry to attain scale that would reduce unit cost as un-subsidized markets would not enable companies to have the patience to increase production capacity. The feed-in tariff was a simple flat price available to anybody and it did not change with inflation or electricity prices. There was not need to negotiate a purchased power agreement ("PPA") and the tariff was not limited to selected corporations. And the German policy worked. As shown in Figure 4.2, the feed-in tariff was able to be dramatically reduced to the point where it is almost competitive with conventional technologies. The tariff had spurred new industry capacity and the increasing scale led to lower per unit (per kW) costs of all sorts of equipment.

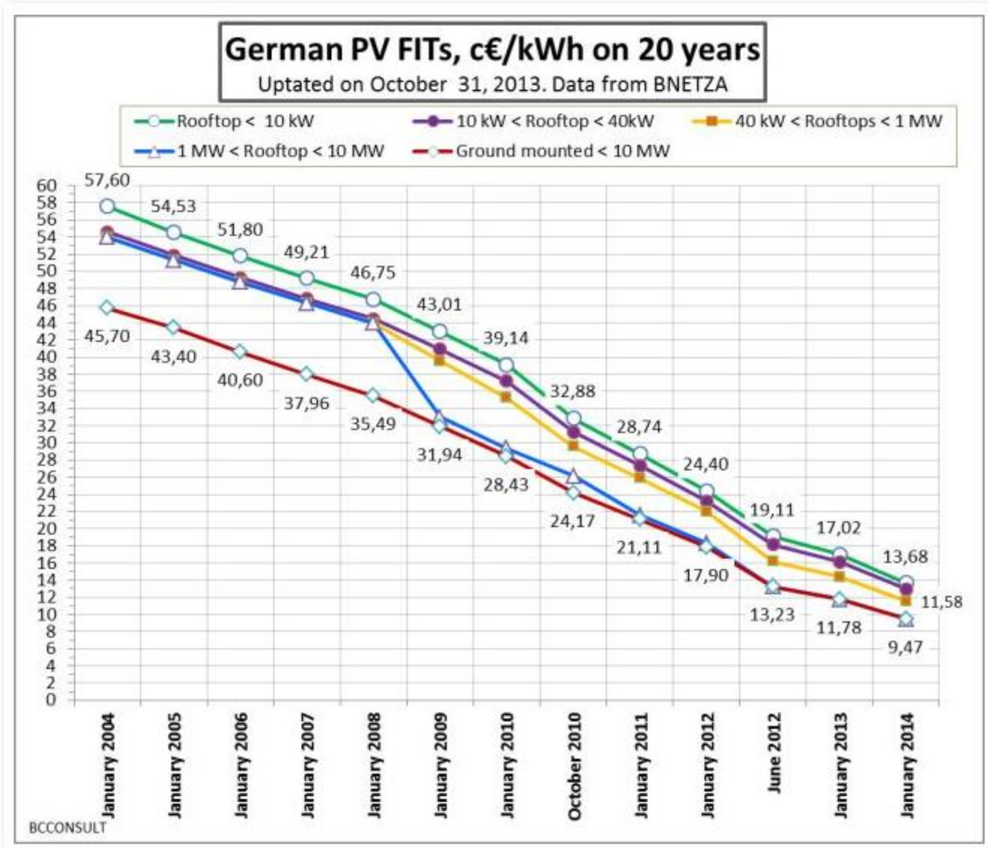


Figure 3: German PV FITs history from 2004 and up to January 2014

Figure 4.2 – German Feed-In Tariffs from 2004-2014

The high cost of solar power was driven by: (1) the fact that the sunlight does not produce the same amount of energy over the course of the year and over the course of a day meaning that the capital cost must be spread over a limited units produced; (2) the relatively high capital cost of an installed system including panels, wiring, inverter costs, racks and labor (in 2010 the cost per kW of maximum power output was more than an expensive coal plant); (3) the cost of capital as solar power from PV is probably just about the most capital intensive endeavor on earth; and (4) operation and maintenance costs that should be modest and require cleaning of panels at night time as well as insurance, inverter replacement and administrative costs.

The Stanford write-up of First Solar included general discussion of the levelized cost of electricity that is supposed to put together the various drivers and compare solar power to other technologies. The levelised cost of electricity (LCOE) has some similarities to the production cost of oil discussed in Chapter 3 and is frequently discussed in the industry. The levelised cost measures average cost over the life of a project adjusted for a given discount rate and is better

expressed in real terms as the current cost of electricity. Costs comparisons are not adjusted for dispatchability nor the ability to quickly adjust to changes in demand. Issues listed in the case write-up involving LCOE included whether solar power could be competitive with other sources and the competitive advantage of the thin-film panels produced by Firstsolar relative to other panels made from silicon (refined sand) that are now often produced in China.

To calculate the LCOE and production cost of electricity from solar power, many of the necessary inputs can be approximated from public sources on the internet. A website called PV Insight lists the cost of panels (as well as the price of silicon). Other websites can be used to find the average amount of solar energy available relative to the maximum amount of power the panels can produce at industry defined standard testing conditions (sunlight of 1,000 kWh/m^2 and temperature of 20 degrees). Industry benchmarks can be used for the cost of equipment other than panels (known as balance of plant) and for operation and maintenance. Finally, the cost of capital must be input that depends on required IRR, interest rates, debt terms, inflation rates and taxes. Using public data and different cost of capital estimates, the range of production costs from solar power is shown in Figure 4.3. As with other analytical tasks, details of the production cost calculation can be reviewed with a video at www.edbodmer.com. Alternatively derivation of LCOE and production cost analysis is discussed in detail in Part 4. The progression chart in Figure 4.3 moves from an assumed project in Ukraine with high cost of capital and low solar resource, to a project in Brazil with good solar resource and a low assumed cost of capital in the Abu Duabi.

INSERT FIGURE 4.3

Once issues associated with the overall solar power industry are addressed, the difference between the thin film technology of First Solar is contrasted to the more common polysilicon technology. The position of First Solar in terms of manufacturing cost relative to other manufacturing companies is addressed. The competing technology, Polysilicon panels are made by essentially sawing refined silicon (which is a semiconductor and can produce electricity) into thin square panels. The type of modules produced by First Solar, thin film panels, did not require silicon (a module represents perhaps twelve panels and an array may have 50 modules). Polysilicon or c-Si panels had represented about 80% of the market in 2010 and the trend continued in subsequent years. Even though the thin film panels needed substantially less raw material because the process involved coating a thin layer of semiconductor material on top of a substrate or base material such as glass, they had a lower efficiency in terms of producing sunlight irriadiation (measured in kWh) into electricity energy (also measured in kWh). The lower

efficiency means that more panels, sunlight and land were required to generate the same amount of electricity. This can increase operation and maintenance, land payments, wiring and other costs. According to the public database provided by RetScreen in Canada, the current efficiency of a First Solar panel is ___% while the efficiency of a polysilicon panel made by Trina Solar panel is ___%. The ratio of the efficiency of ___ times for the polysilicon would imply wiring costs, land costs and some O&M costs would increase by ____.

The Stanford case study write-up which was so complementary of First Solar suggested that the First Solar's thin film technology had an inherent cost advantage as compared to the polysilicon manufacturers: "[t]he simplicity of CdTe chemistry allowed its capital costs per watt of production to be substantially lower than that for competing technologies." This cost advantage came from the high capital expenditures required to refine silicon and the silicon prices that existed before 2008. But the cost advantage changed dramatically with a drop in polysilicon prices beginning in 2010. In 2008 the price of silicon began to fall dramatically from what arguably was a bubble before 2008. The fall was blamed on surplus capacity in the case, but as shown in Figure 4.2, the price of silicon continued to decline. Indeed, the price of silicon had spiked. had a price bubble where prices were far above long-run marginal cost. This prompted many companies to enter the business and the price has been below USD $20 after 2013. A question not addressed in the case is how low the silicon price had to be in order for polysilicon to be competitive with thin-film. A second question not discussed is why thin-film represented a small fraction of the market (approximately 20%) if it had such cost advantages. The final question is why companies were new production was using polysilicon when the production process for thin film was "relatively simple."

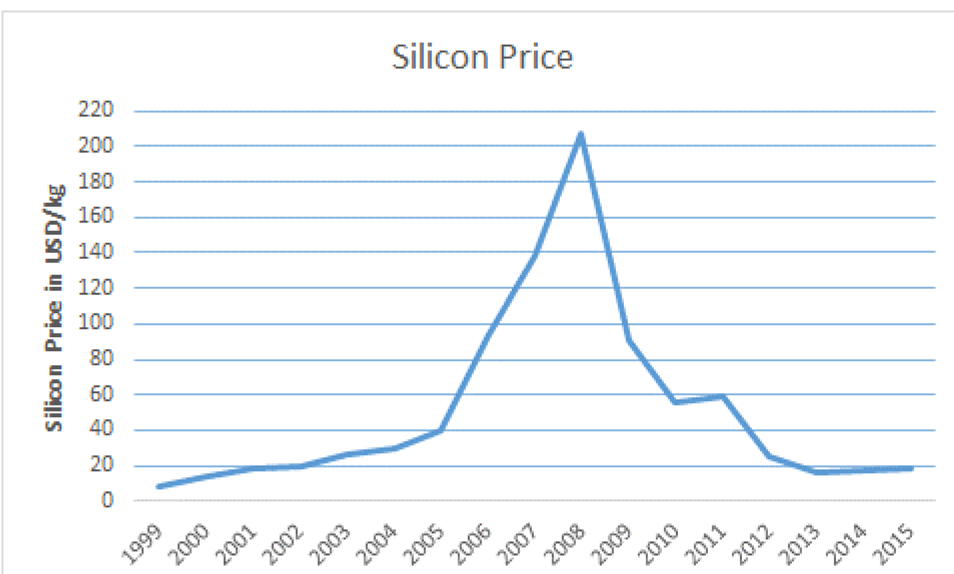
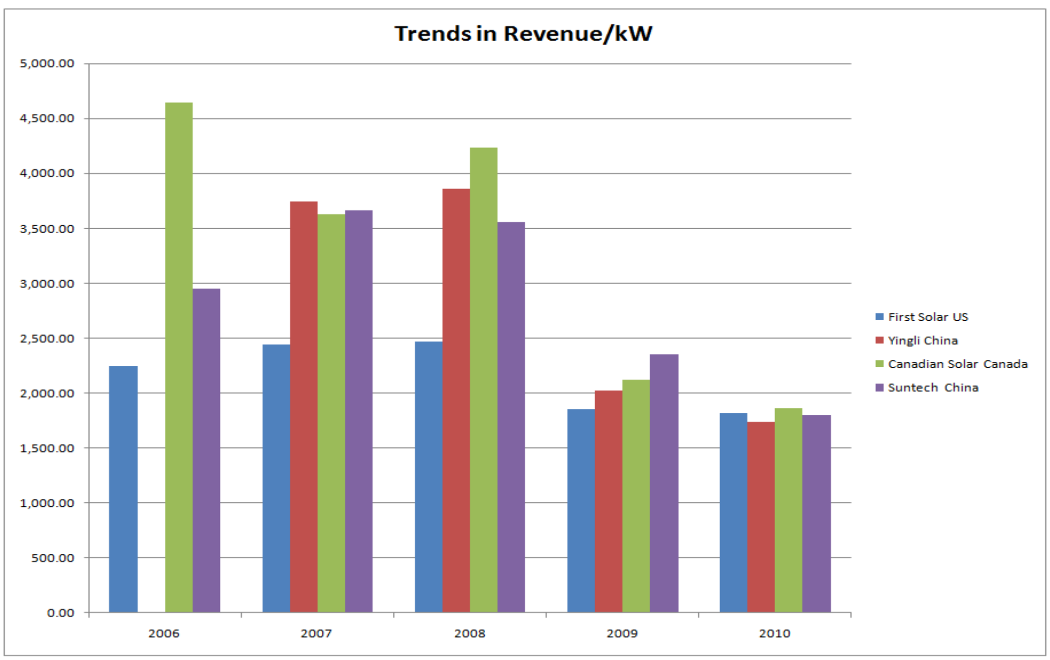


Figure 4.4 – German Feed-In Tariffs from 2004-2014

The case write-up states that "crystalline silicon (c-Si) prices had dropped precipitously in response to overproduction, substantially reducing the Levelized Cost of Electricity (LCOE) differential between c-Si and First Solar's thin film modules."[26] While there was an increase in industry capacity, the question is whether dramatic price reductions that occurred over the past few years had been due improvements in productivity, declines in the cost of input materials and reductions in high profits enjoyed by companies or whether it was due to surplus capacity. Measurement of the production cost of different panels using LCOE mentioned in the above quote may be valid, but if First Solar's thin film technology had a big cost advantage relative to silicon technology, it should have been the dominant technology in the industry. It was not then and it is not now.



The declines in cost were driven in a large way by reductions in the cost of panels. Figure 6.2 shows that module costs were in the range of USD 3,500 per kW in 2008. In 2015, the costs are as low as USD 500/kW.[27] Due to reductions in the price of polysilicon (created from heating sand), the prices polysilicon modules

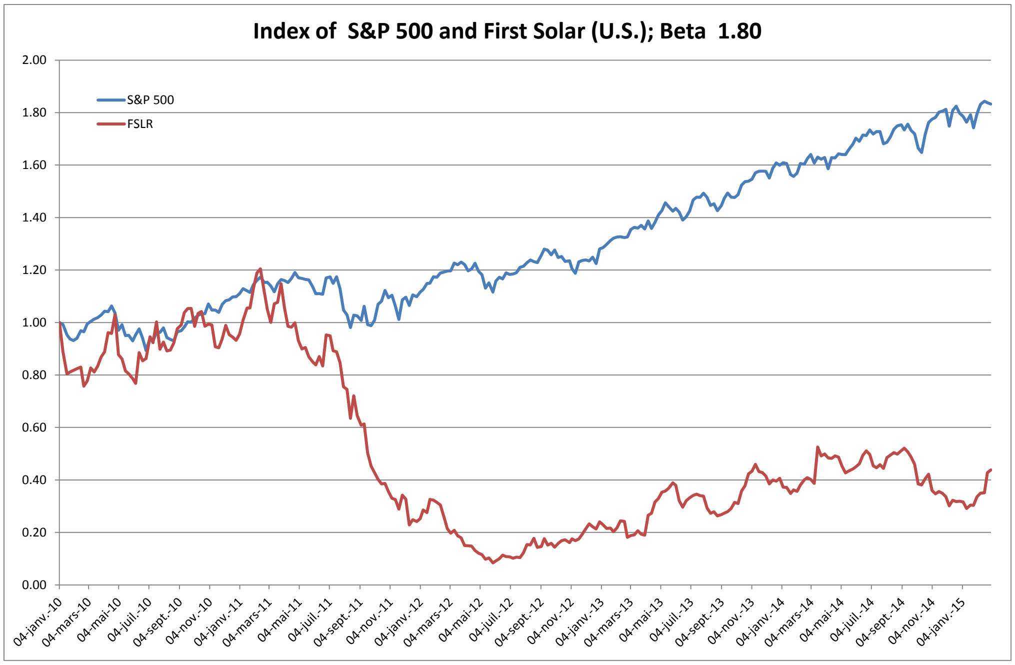
[26] First Solar, Inc. in 2010, page 2.
[27] Figure 6.2 is derived from annual reports; current costs can be derived from the website www.pvinsight.com

produced by competitors of First Solar declined faster than the First Solar modules. Other costs of installing solar power farms include the cost of an inverter that converts power from direct current to alternating current, installing structures, wiring and labor. The majority of costs for a solar project are now comprised of these other costs. The industry seemed to be high tech and maybe the next Google or Microsoft.

Can get information from the financial reports.

Nobody wants to be a commodity, neither in your own career nor a company. The only way to make a real profit is through cost reduction. The case write-up describes First Solar's strategy as follows "Downstream integration could prove a sustainable competitive advantage for First Solar. Specifically, the EPC and development businesses provided higher margin sales channels for the company's modules, and they were more resistant to commoditization." The company began to pursue other markets with high solar irriadion and high tariffs in 2009. Not that simple. Rooftops need efficiency. Developing markets need cost of capital. High retail rates fight for policies that will not lose revenues. First Solar purchased a company that integrated solar arrays with balance of system components such as inverters, wiring, engineering and labor. First Solar paid $34.3 million for Turner. Then the company purchased Opti Solar, a troubled developer for $400 million in 2009 of which $250 was goodwill. In 2010 First Solar purchased projects from Edison Mission and it bought another company called Nextlight for $296.7 million. The company had no completed projects and a book value of (296.7-146.7). Nextlight was earning negative income before it was purchased. In 2011, First Solar took an impairment write-off for the acqusitions. It closed its German manufacturing facility.

As the price of modules declined, the profit and the stock price of First Solar also fell. Figures 6.1 and 6.2 Stock price had increased from ___ to ___. Growth of revenues had been. Show graph of stock price.



The solar manufacturing industry was desimated in the years after 2010 leaving the landscape scattered with many bankruptcies. Although the Stanford business case involves strategy such as vertical integration (First Solar purchased an inverter manufacturer and took a write-off for associated goodwill in the next year), the case can be used to address corporate valuation issues.

Timeline for the case.

Valuation Issues in the First Solar Case

Valuation Error 1: Not Evaluating Potential Competitive Pressure with High Returns

The fundamental objective of any business, whether a corporation or a project financed investment is to earn returns above the cost of capital. For a corporation, if returns above the cost of capital are earned, even more value can be gained if growth is achieved. Earning returns above the cost of capital and growing rapidly put a company in the upper right-hand portion of the matrix that is

named powerhouse by consultants. For companies in this powerhouse square, value, the P/E ratio, the EV/EBITDA ratio and the market to book ratio are highest. The fundamental objective of any company should be to get into the square and stay there.

Companies such as First Solar were and are classified as a high technology business in when evaluating stocks along with companies that produce smart phones and semi-conductors.

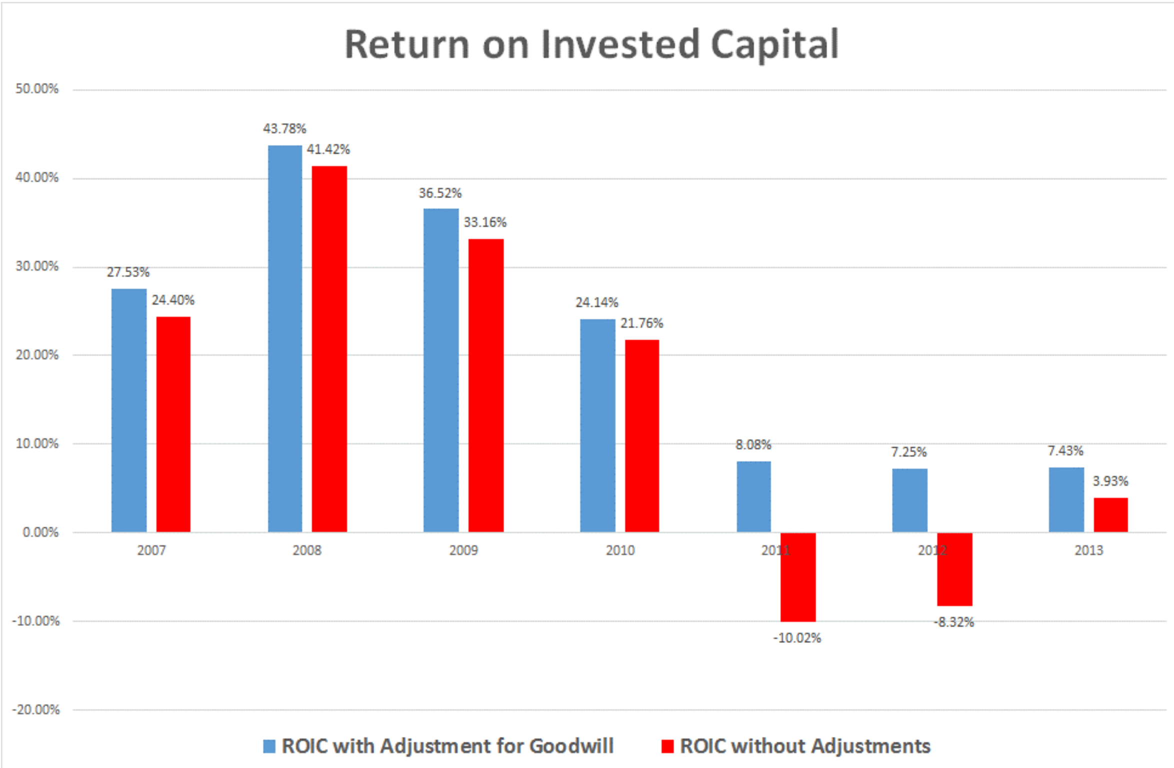
First Solar before 2010 and particularly before appeared to be a classic power house company. It was earning high returns in a rapidly growing industry with strong future prospects. Figure 6.3 shows that stock prices before 2008 were reflective of such a powerhouse. The P/E ratio was about ___ and the market to book ratio was ___ and the EV to EBITDA ratio was ____. Other examples of power house companies may be McDonalds, Apple, Disney and Starbucks Coffee – these companies are successful at earning returns far above their cost of capital by somehow making people feel they cannot live without their products. .

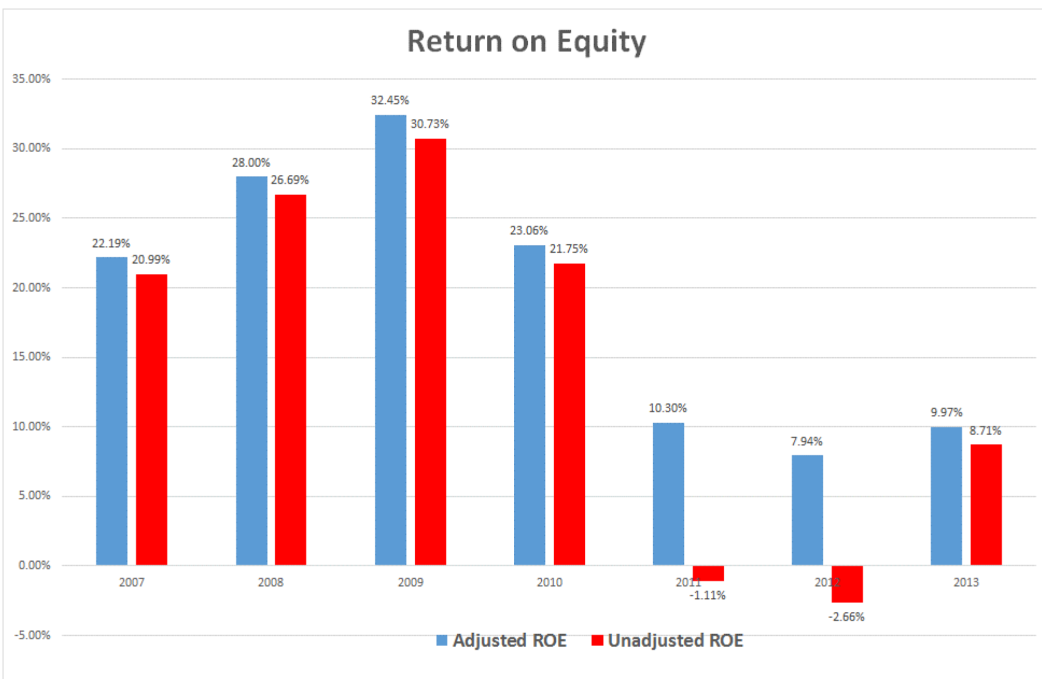
The big problem with the powerhouse square is that everybody else wants to be in the same place. Unless there is something very special that limits other companies from entering the business, time in the powerhouse square can be limited. Maybe Motorola was there when it came out with a portable phone. But it was quickly replaced by Nokia and then Blackberry, Apple and Samsung. When companies come into the powerhouse square, industry supply increases. After industry supply goes up, surplus capacity becomes a big problem, prices can decline to marginal cost and returns drop through the floor. Even without surplus capacity, the desire to enter into the powerhouse square attracts companies that have low cost structure and can effectively compete.

When computing the return relative to the cost of capital, a number of issues arise with respect to computing both the cost of capital and the return. Adjustments to the return can include research and development and write-offs for restructuring and goodwill write-offs. Further issues involve whether to measure the analysis with return on invested capital or return on equity. These issues are described in further detail in Chapter XX. Figure 6.5 shows the return on invested capital with adjustments and demonstrates how returns fell after 2008 and again more significantly after 2011. The adjusted returns are probably somewhere near the range of the cost of capital. The company is in a commodity business and has a good cost of production.

Discuss the true competitive advantage. If competitive advantage, then other companies facing the same pricing pressure would have lower retruns.

Note how difficult the calculation is to be careful about earned returns.


Return on Invested Capital
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
-10.00%
-20.00%
27.53%
24.40%
43.78%
41.42%
36.52%
33.16%
24.14%
21.76%
8.08%
-10.02%
7.25%
-8.32%
7.43%
3.93%
2007
2008
2009
2010
2011
2012
2013
ROIC with Adjustment for Goodwill
ROIC without Adjustments


Return on Equity
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
-5.00%
22.19%
20.99%
28.00%
26.69%
32.45%
30.73%
23.06%
21.75%
10.30%
-1.11%
7.94%
-2.66%
9.97%
8.71%
2007
2008
2009
2010
2011
2012
2013
Adjusted ROE
Unadjusted ROE

Maybe will come back when the price of polysilicon increases. But then would have to assume that nobody else would come into the market.

Given the decline in prices industrywide, a second question is whether First Solar had some kind of manufacturing advantage that meant it could continue making profits while other companies were suffering losses. While the solar industry may seem to be exotic, the general manufacturing procedure involves putting parts together or cutting polysilicon into sections. The process is not very capital intensive (capital intensity can be measured as revenues divided by assets) and the big costs are materials and labor. Unlike coffee, theme parks and smart phones can differentiate their products, there is limited potential to make consumers addicted to different brands of solar panels. Decisions to choose one panel type over another are based purely on cost.

Refer to PV insight.

Discuss the price of polysilicon.

Valuation Error 2: Valuation from Management Projections Combined with Prospective P/E Estimate

In 2010, Value Line Investment projected the stock price in two years to be between ___ and ___ while the current price was ___. A couple months later the pThe case study states that: “[t]he well-developed European ecosystem of developers and systems integrators made the cell and module production business model a viable one for First Solar.” Translated, this means that each company

Return on Net Assets (RONA) was the metric CFO Meyerhoff used to measure the financial performance of the company as it captured both P&L performance and capital efficiency. He further explained:

I look at my business as having four cost columns that must be managed: the module, EPC, development costs, and the WACC. We have intentionally underlevered at the corporate level, which means that my WACC is higher than it needs to be there. However, I get a much better WACC as a result for my projects. Then I can drive up my corporate asset turnover through more module sales and

my margins increase because I don't have to pay as much for debt. Overall, I get a much better RONA this way than by lowering the corporate WACC.

2005	2006	2007	2008	2009	2010	2011	2012	© VALUE LINE PUB. LLC	14-16
1.06	1.87	6.41	15.27	24.24	29.86	**42.50**	**53.65**	Sales per sh A	**84.20**
d.07	.20	1.73	5.00	9.03	9.55	**11.60**	**13.15**	"Cash Flow" per sh	**17.40**
d.14	.07	1.43	4.24	7.53	7.68	**9.40**	**10.70**	Earnings per sh A B	**14.85**
--	--	--	--	--	--	**Nil**	**Nil**	Div'ds Decl'd per sh	**Nil**
.94	2.12	3.08	5.63	3.28	6.86	**12.50**	**6.75**	Cap'l Spending per sh	**9.45**
.29	5.69	13.96	18.54	31.13	40.25	**48.50**	**58.65**	Book Value per sh	**81.20**
45.21	72.33	78.58	81.60	85.23	85.84	**88.00**	**89.00**	Common Shs Outst'g C	**95.00**
--	NMF	73.1	50.7	19.3	16.5	*Bold figures are Value Line estimates*		Avg Ann'l P/E Ratio	**25.0**
--	NMF	3.88	3.05	1.29	1.06			Relative P/E Ratio	**1.65**
--	--	--	--	--	--			Avg Ann'l Div'd Yield	**Nil**
48.1	135.0	504.0	1246.3	2066.2	2563.5	**3740**	**4775**	Sales ($mill) A	**8000**
NMF	9.6%	32.1%	39.9%	39.2%	35.3%	**30.5%**	**28.0%**	Operating Margin	**25.0%**
3.4	10.2	24.5	59.5	129.6	156.1	**205**	**225**	Depreciation ($mill)	**275**
d6.6	4.0	111.7	348.3	640.1	664.1	**815**	**947**	Net Profit ($mill)	**1380**
--	56.7%	28.4%	24.9%	6.7%	12.8%	**13.0%**	**15.0%**	Income Tax Rate	**20.0%**
NMF	2.9%	22.2%	27.9%	31.0%	25.9%	**21.8%**	**19.8%**	Net Profit Margin	**17.2%**
d7.3	336.4	616.0	695.6	956.4	1114.8	**1630**	**2205**	Working Cap'l ($mill)	**3630**
28.6	61.0	68.9	163.5	146.4	210.0	**210**	**210**	Long-Term Debt ($mill)	**210**
13.1	411.4	1097.3	1513.0	2652.8	3455.0	**4270**	**5215**	Shr. Equity ($mill)	**7715**
NMF	.9%	9.8%	20.9%	23.0%	18.1%	**18.0%**	**17.5%**	Return on Total Cap'l	**17.5%**
NMF	1.0%	10.2%	23.0%	24.1%	19.2%	**19.0%**	**18.0%**	Return on Shr. Equity	**18.0%**
NMF	1.0%	10.2%	23.0%	24.1%	19.2%	**19.0%**	**18.0%**	Retained to Com Eq	**18.0%**
--	--	--	--	--	--	**Nil**	**Nil**	All Div'ds to Net Prof	**Nil**

2014-16 PROJECTIONS

	Price	Gain	Ann'l Total Return
High	445	(+255%)	37%
Low	295	(+135%)	24%

Valuation Error 3: Failure to Interpret Ratios that Measure Market Value to Investment Contribution in Gauging Value

The focus of valuation is generally on the P/E ratio and the EV/EBITDA ratio. A third benchmark, the price to book ratio or the enterprise value to investment value can provide insight.

Discuss the idea of the market to book ratio. Show how First Solar has worse ratio than others. Also note that this is a check on the cost of capital.

In 2010, Value Line Investment projected the stock price in two years to be between ___ and ___ while the current price was ___. A couple months later the

pThe case study states that: “[t]he well-developed European ecosystem of developers and systems integrators made the cell and module production business

Valuation Error 4: Assuming that High Profits Gained from Government Subsidies could Continue

The case study states that: “[t]he well-developed European ecosystem of developers and systems integrators made the cell and module production business model a viable one for First Solar.” Translated, this means that each company along the value chain was able to earn high profits when feed-in tariffs were high. The foundation for First Solar returns as well as the returns for other segments of the business were the feed-in tariffs that allow investors to earn high profits. This is analogous to the PPA agreement that allowed Enron to earn a project IRR of more than 20%. Maintenance of this performance required a number of assumptions that were not plausible with hindsight. First, it assumes there would be no political pressure to reverse the policy; second, it assumed that the public would not understand that surcharges that appear on electric bills are not flowing to foreign companies; third it did recognize the risks that subsidies could suddenly disappear. The investment really depended not on the manufacturing process of producing thin film panels, but rather on administrative procedures of European governments. There were stories in Spain of solar producers cheating with measurement of energy fed into the grid and of people seeing container loads of solar panels arriving from China while electric bills.

Not only did Spain eliminate prospective subsidies, but they were changed on a retroactive basis. The analogy grows closer to the Enron Dabhol plant. The amount of production subject to the feed-in tariffs was limited; additional taxes were imposed on owners of the projects and finally the tariffs were adjusted on an individual basis to allow the earning of a regulated return.

Implied that could earn returns from competing against retail rates

Valuation Error 4: Accepting Overconfident Beliefs that it can Change its Strategy and Maintain High Returns

Much of the case was about moving into different segment of the industry. Could become an EPC contractor. Could become developer. Along with this idea is the notion that solar can compete without subsidies.

Show the economics of solar power in different places.

Discuss the economics of solar power and the revolution.

First question is how to compute returns. Problem with ROE is that includes financing and cannot isolate on what returns are made from what company is really doing. Use Apple as example. The show ROE and ROIC for First Solar. With high subsidies, many people split. Use Spanish example where did not uphold contracts. Most importantly Chinese companies came into the industry quickly. Show the power house graph with arrow.

Chapter 5

Relying on Uneconomic Investments and Contracts - the case of Enron's Dabhol Plant

Summary of Conceptual Valuation Errors Made in the Case

The case study discussed in this chapter is a second project financed transaction meaning a single investment is evaluated for its life and there are no historical financial statements for the company. The situation involves a power plant named Dahbol that was developed in India by Enron. This investment has some similarities with the Petrozuata case discussed in Chapter 3, in particular the idea of earning a high IRR for an off-shore investment. However in for this investment, the political risks and other potential problems were addressed by using a series of different contracts, the most important of which was a purchased power contract with the state owned power company that distributed power in the Indian State of Maharashta. The has many similar issues to the Petrozuata case except that

The Dabhol power plant in India remains one of the most controversial project financed electricity plants since the first independent electricity plants were established in the 1970's. At the time it was developed near Mumbai, it was the largest investment made by a western company into a developing country. Failure of the project in 2001 was arguably a big contributor to the downfall of Enron Corporation as it opened questions about projected income that had been considered secure (and perhaps even recorded as current income). Failure of the project also was bad for India. After the State Utility Company defaulted on its purchased power agreement, the country had trouble attracting foreign capital for many years and it was not until Dick Cheney got involved that investors got their money back. The project has been controversial from the standpoint of project finance analysis and policy. On one side, some suggest that India was crazy to not honor its contracts. The other side of the argument was that the project was never economically viable and financers should have understood this.

Three different Harvard case studies were written about the Dabhol project in 1996, 1997[28] and 2000.[29] Each of the three case studies were written in a generally supportive manner for the Enron positions perhaps because many Enron executives had earned their business degrees at the Harvard Business School. The first case was unambigiously positive about the project and called Enron, “ “, The second case, written after the government cancelled the key contract for the project, emphasized the political events that lead to early problems with the plant. For example, authors of the case write-up stated: “As the committee began its scrutiny, momentum to call off the project increased and many recognized the visible and public review process as a veiled but pivotal campaign issue designed to become a re-election driver for the BJP in the next national elections.” The third HBS write-up documented the re-negotiated PPA and documented that Sanjay Bhatnagar, the managing director of the plant and Rebecca Mark the president of Enron’s international operations, had both “earned an MBA from the Harvard Business School.” In addition to the HBS write-ups first case study Four different Harvard Cases and two case write-ups from India.

The analogy of analogy of an amorous relationship and project finance can be continued for the Dahbol case. This time, the relationship is a very quick engagement without much testing of the market. After a quick ___ period, a marriage contract along with a pre-nuptial agreement is signed. This time, unfortunately, one party is not happy with the contract and arguments make the whole project difficult for all parties.

The Power Purchase Agreement (PPA) between the Maharashtra State Electricity Board (MSEB) and the Dabhol Power Company (DPC) had been signed in December 1993 after intense negotiations.

It was a good project for Maharashtra and for us. We did not bribe anyone, and were ready to walk if we had to.

Beginning the analysis with analysis of costs and benchmarking rather than evaluating the details of contracts that are supposed to transfer risk to other parties

[28] Srinivasan, Sarayu under the supervision of Professors Krishna G. Palepu and V. Kasturi Rangan, Enron Development Corporation: The Dabhol Power Project in Maharashtra, India (B)”, Copyright © 1996 President and Fellows of Harvard College.

[29] Srinivasan, Sarayu under the supervision of Professors Krishna G. Palepu and V. Kasturi Rangan, “Enron Development Corporation: The Dabhol Power Project in Maharashtra, India (C)”, Copyright © 1996 President and Fellows of Harvard College.

Evaluating the production costs through evaluating fixed and variable costs rather than attempting to put the costs into a single number

Assuming that high earned equity IRR's can be sustained in long-term contracts without pressure to later attempts to renegotiate the contracts.

Presuming that contracts with wholesale entities can be sustained with working through the effects of the contract on ultimate consumers who much pay the bills

Enron constructed the plant after it negotiated prices in a contract with the State of Maharashtra in which the prices would yield high returns and they would most likely remain above the long-run marginal cost over the lifetime of the plant. Financial problems associated with this very large power plant that arose after the contract could not be sustained were a significant contributor to Enron's financial demise in 2001. The plant was supposed to run on liquefied natural gas ("LNG") in contrast to other plants in India that generally used coal; it was the first large independent power project developed in India; it was the largest foreign direct investment in the world; it was Enron's largest single power investment; the cost of the power contract would comprise 50% of the total revenues of the distribution company in Maharashtra; and the project included construction of an LNG terminal, an LNG regasification and an LNG tanker.

Synopsis of the Case

Enron began developing the Dabhol electric station together with its co-sponsors Bechtel and GE in 1992 soon after the national government of India announced that the power markets would be open to foreign investors. A memorandum of understanding was signed with the State of Maharashtra when Enron's executives made their first trip to India which mandated that the maximum price of power would be 7.3 cents per kWh. In 1993, Enron and the State reached an agreement on the size of the plant and the contract to purchase power, even though a World Bank report strongly criticized the plant. Enron arranged financing from more than 40 financial institutions for the project and was able to achieve a debt to capital ratio of more than 70% as shown on the figure below (Enron later sold part of its stake in Phase I to the State of Maharashtra). The plant was ultimately scheduled construction for completion in two phases -- in 1999 and 2001 -- with a capacity to produce 2,184 MW of power. The capacity of Dabhol represented more than 20% of the total capacity in the state of Maharashtra when the contract to purchase power was signed. A contract dispute arose between Enron and the new political party in the State of Maharashtra which ran on an anti-Enron campaign (who proposed "throwing Enron into the Arabian

Sea".) After a new contract was signed, the plant was closed in 2001 after running for about a year and it did not produce any power until May 2006. Dabhol plant continues to raise strong emotions from different parties. Project Finance bankers and lawyers insist that the Government of India made big mistakes by not living up to a commercial contract which reduced foreign investment and limited the development of infrastructure in the country for years. Others point political pressure that was used by the highest levels of the U.S. government to support an uneconomic investment; to the $20 million of "educational funds" made by Enron which were to explain how capitalism works; environmental problems with the plant and the lack of competitive bidding for the power. The focus below is on the question of how risks of the contract could have been evaluated through evaluating underlying marginal cost rather than on the perhaps more interesting geopolitical issues.

"It was clear to us that the tariff had to be brought to about Rs 1.9/KwH and the project cost to under Rs 3 Crores per MW to be in the ballpark of other concurrent projects. Moreover, Enron's own Teeside project in the U.K. provided a useful benchmark. We gathered all data possible and attempted to make an apples-to-apples comparison, knowing fully well that one power project is not directly comparable to another."

There was no doubt that the stakes were high; interest payments and other project delay costs were surpassing $250,000 per day, which the Maharashtra government would have to pay if it lost in the arbitration proceedings

Use the timeline in Indian Case.

Dabhol Sources and Uses (Dollars in 000's)

	Phase I		Phase II	
	Amount	Percent	Amount	Percent
Sources of Funds				
Debt Financing				
Bank of America/Private Banks	150,000		497,000	
Indian Banks (Industiral Development Fund)	95,000		333,000	
OPIC	100,000		60,000	
U.S. Exim and Export Agencies	298,000		523,800	
Total Debt	643,000	70%	1,413,800	76%
Equity Financing				
Enron	223,000			
Bechtel	28,000			
GE	28,000			
Total Equity	279,000	30%	456,667	24%
Uses of Funds				
Cost of LNG Terminal			250,000	
Other Costs			1,620,467	
Cost of Project	922,000	100%	1,870,467	100%
Capacity (MW)	695		1,320	
Cost per KW	1,326.62		1,417.02	

Given the importance of the power sector to India's economic development, the government decided to fast-track eight projects to induce foreign investment in this sector as part of a wider program of economic liberalisation. These projects were to be initiated through individual negotiation rather than public tendering and also enjoyed support from the central government, including certain guarantees. Phase I of the Dabhol power plant was the first such project to be launched and was widely seen as the flagship initiative marking the opening of India's domestic energy sector to foreign interests.

Over the 1999-2005 period, potential foreign investors in India pointed to the DPC debacle as an indication of the unacceptable level of political risk in India. "The trouble with India's investment climate," Christina Rocca, U.S. assistant secretary of state said in a July 2001 speech in New Delhi, "was to be summed up in a five-letter word: Enron."4 In March 2005, an article in the Wall Street Journal claimed that, "Many businessmen and diplomats say that settling the debts of the $2.9 billion Dabhol project — India's largest ever foreign investment — is a prerequisite for future financing of other big-ticket infrastructure ventures in India."5

Mark's vision was for Enron to become the largest distributor of liquefied natural gas ("LNG") in India, requiring capital investment of up to US$20 billion by 2010. In this vision, Enron would set up two LNG terminals and re-gasification units, the first being at Dabhol in Maharashtra. LNG would be imported to meet projected national needs through a terminal facility that Enron was building in Qatar, a gas-rich Gulf state.

A further Enron subsidiary wasmade turnkey contractor for the re-gasification plant.

Dabhol then lay idle for several years as sponsors, domestic and foreign financial creditors, and national and state governments spun a web of settlement, damages and counter claims. In March 2004, Indian receivers took control of the Dabhol plant and foreign commercial lenders terminated the PPA one month later. At the same time, Bechtel and GE acquired Enron's 65% stake in DPC for US$23 million through an American bankruptcy court and initiated arbitrations to make good their losses.

2005, the government had concluded the arbitration and legal cases arising from Dabhol after settling with Bechtel, which received US$160 million in settlement, 94 and GE, which accepted US$145 million.95 Both sought to

minimise their losses, and unlike DPC's financial creditors, were able to use the leverage in bargaining that technical resources had been provided, without which restarting the power plant would be difficult to achieve.

Amounts overdue to 19 overseas lenders were settled for US$230 million at a 20% discount while OPIC received a settlement of US$228 million from India's Gas and Power Investment Company Limited funded by domestic lenders including IDBI, ICICI Bank, IFCI and Canara Bank, and the sale of domestic bonds.98 The settlement with foreign debtors enabled Dabhol to be revived, and the plant was restarted in April 2006.

In the days prior to July 18, the government of India was able to negotiate a reduction of 20 per cent in the face value of DPC's bank loans, and it was able to purchase GE's equity for $145 million and Bechtel's equity for $160 million. The total payment was $760 million. Rather than paying this out of its fiscal budget, the government convinced Indian financial institutions to provide this capital. As a result of these negotiations, Prime Minister Singh was able to meet President Bush in an atmosphere of cooperation. Singh hoped that he had reduced the foreign perception of India's political risk, and that there would be a rapid increase in FDI.

Rs. 2.40/KwH (7.03 cents/KwH) excluding customs and duties for 20 years with 4% annual escalation on fixed charges.

Phase I: Rs. 2.03/KwH (6.03 cents/KwH) till phase II operational subject to fuel price and exchange rate fluctuations.

Phase II: Rs. 1.86/KwH, (5.08 cents/KwH) subject to fuel price and exchange rate fluctuations for 20 years with no escalation.

Valuation Issues in the Enron Dahbol Case

Valuation Error 1: Trusting Contracts without Evaluating Underlying Economics

For projects that receive revenues on the basis of market driven prices, the most important component of valuation analysis is generally the assumptions with respect to future price projections that underlie the forecast of future cash flow. This is true also for projects that have long-term price contracts because if the contract price differs by a wide margin from prices that would arise from spot

markets or from current costs, there will be a lot of pressure to exit the contract. While coming up with a long-term forecast prices is certainly not an easy task, one principle that can provide some structure to price forecasts is that in a reasonably competitive market, prices cannot indefinitely be sustained above or below long-run marginal cost. A corollary to this principle that prices converge to marginal cost is that when oversupply exists in a market, prices remain below long-run marginal cost until demand justifies construction of new capacity and that where a lot of over-supply exists, prices can fall all the way down to short-run marginal cost. While these economic principles are quite basic, many valuation errors have been made by assuming that fundamental of economic principles somehow will not apply to a particular investment. Further, analysts often concentrate on the demand side of the process which does drive volatility and short-term price movements. However, over the long lifetime of an investment, assuming that prices remain well above or below marginal cost -- the supply side of the equation – is dangerous.

The case in this chapter involves valuation errors made from not adequately projecting the future level of prices through ignoring or misapplying marginal cost as a guide to the direction and level of long-term prices. The case used to illustrate this problem of ignoring marginal cost and/or wrongly assessing marginal cost can affect value is the large electricity plant named Dabhol constructed by Enron in the Maharashtra Sate of India.

Valuation Error 2: Failure to Benchmark Cost in Assessing Project Viability

Use of multiples to benchmark in corporate finance and requirement to benchmark in project finance. Each project is somewhat unique. Can earn returns in different ways.

One simply computes the capital and operating cost of adding new capacity to the system on a per unit basis. (Chapter 6) However, when capacity can be added with different technologies that have different tradeoffs between fixed and variable cost (as is the case for most industries) the marginal cost is more complicated to compute. Consider for example the case of an airline deciding what kind of airplanes to add to its fleet. The economic analysis and the marginal cost of owning a ten-year old Boeing 737 is very different than the analysis of a new Airbus A380 and one use the cost of one technology to substitute for the other. Similarly, copper or coal mines with different mixtures of fixed and variable cost may both be economic, but the prices required to keep the mines operating is very different. Finally, even if a project is efficiently constructed at a

low cost, if it is the wrong technology because of an oversupply of plants with a certain cost structure, it may be an uneconomic investment and its cost may be above the overall marginal cost. (Chapter 6)

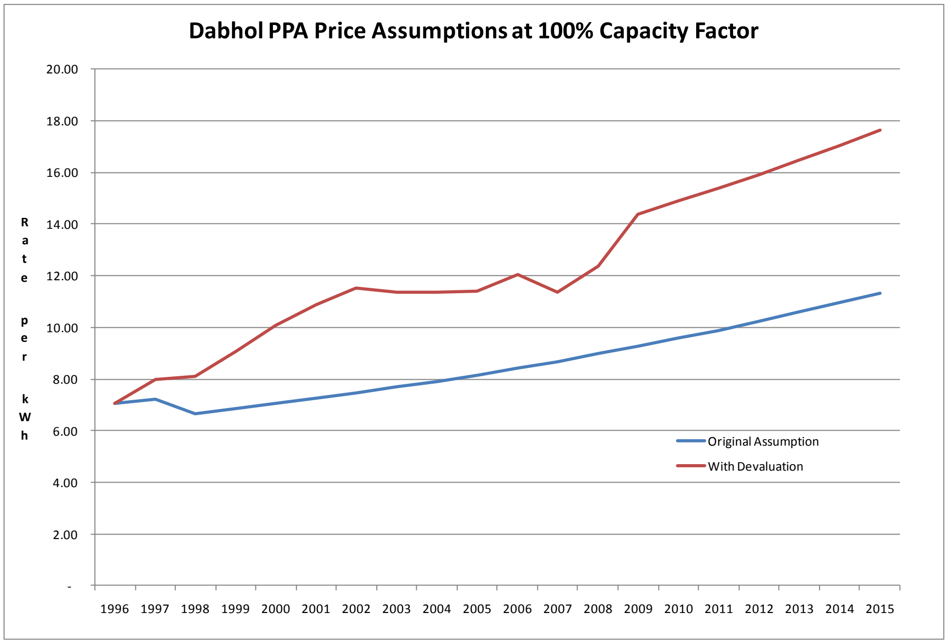
Valuation Error 3: Assuming High IRR's Do Not Directly Contribute to Political Risk

What was IRR and how could compute.

Increase in IRR from selling project when the project risk and the country risk decline. Refer to chapter.

In assessing the cost of Enron's Dabhol plant, it was ambiguous how high the cost was and even whether the plant costs were higher than long-run marginal cost. To make the analysis, it was necessary to come up with an effective definition of marginal cost. The definition of marginal cost is driven by capital costs of building net capacity, the cost of capital, projected increases in productivity, forecasted operating expenses and other factors such as tax rates and equipment lives. In the case of the Dabhol power plant, when Enron and the State of Maharashtra negotiated the original contract, Enron agreed to establish a price of 7 cents per kWh. This simplistic mandate turned out to be a big problem for Maharashtra as Enron was able to come up with a price of 7 cents price and at the same time produce a high level of profit for itself through mandating that the plant would run as long it is available and by inflating the price over time. This worked for Enron because the fixed costs could be spread over as large as possible a volume on energy. The problem with this is for consumers in Maharashtra is that the contract that mandated the plant would run as much as possible did not reflect the variable cost of operating a plant that must purchase LNG or naphtha which and has a much higher than the running costs of other plants such as coal plants. If the Dabhol plant operated and caused Maharashtra to pay its cost of producing energy from LNG while lower cost plants were available and not running, then there was a waste that was benefiting nobody. It is as if you choose to drive an inefficient low mileage SUV instead of a hybrid when there is no benefit from the added space in the SUV. When Dabhol was operated in the order of its variable cost in 2000, its utilization was as low as 33% rather than the above 90% required to obtain a price of 7 cents. Part of the problem was that the optimistic demand forecasts (growth in demand of above 10%) that were originally made for the plant did not materialize. All of this means that the 7 cents number that Enron published was not relevant. The real cost of the plant depended on how often it was economic to operate the plant as well as the exchange rate. There was 49% devaluation in the Rupee which led to an increase in price because the power

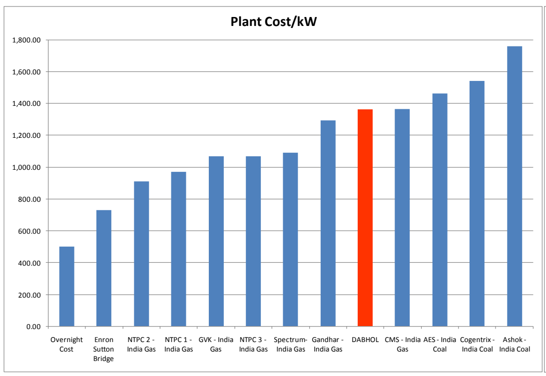
contract was indexed to U.S. dollars. The graph below shows the price in the contract assuming the plant would be operated at full capacity using the original exchange rate assumptions and actual exchange rates.

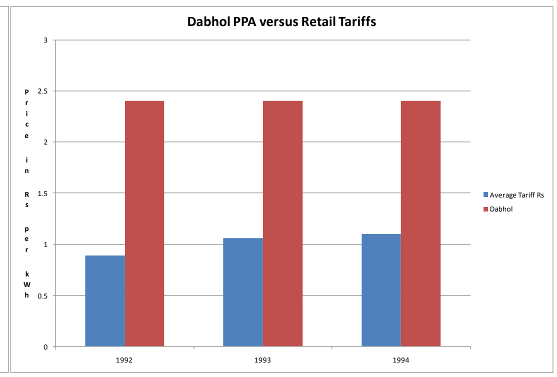


Valuation Error 4: Not Evaluating the Cost of Production through Combining Capital Cost, IRR, Fixed Cost and Variable Cost

A couple of years after signing the contract, the State-owned distribution company that purchased power and officials from the State of Maharashtra believed the contract price was too high and by implication that investment in the LNG plant was not economic. The plant had began operations in 1999, but by October 2000, the State-owned utility company stopped paying for the power. Enron was an aggressive negotiator and had obtained what seemed to be very strong guarantees from the State as well as the federal government of India. Ultimately, the process of realizing these guarantees turned out to be very difficult to effect and resulted in years of litigation. The story demonstrates that bankers and sponsors should have concentrated more on thinking about the underlying economics of the project and less on taking comfort from government guarantees.

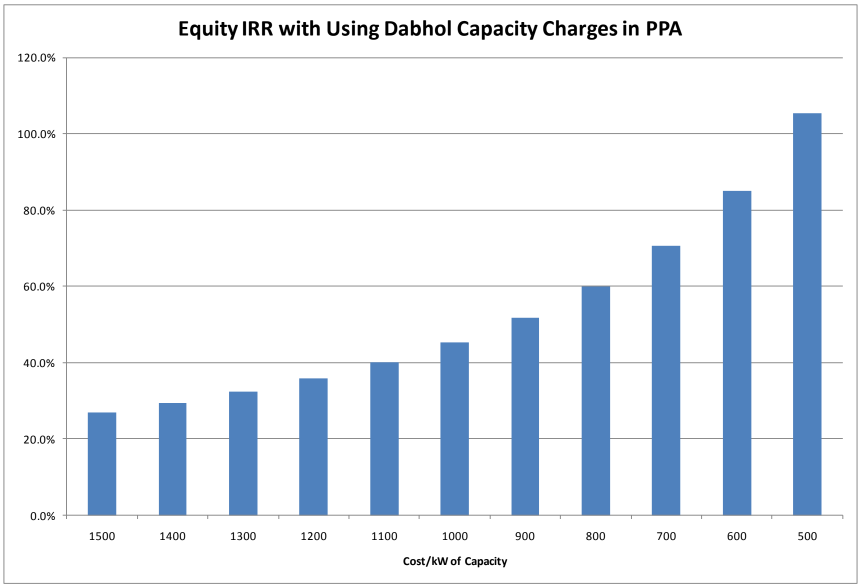
Further, in assessing the cost of the power from the project, one had to separate the aggressive arguments of Enron from political arguments made by the project opponents. Enron would send people with MBA's from Harvard who spoke very fast, used sophisticated language and suggested that their projects were very beneficial. Their presentations would be supported by three ring binders with glossy pictures that were very impressive. In Harvard case study write-ups on the plant that were written with the help of Enron management compared the plant costs and attempted to show that the cost was not dramatically higher than the cost of other plants in India as shown in the left panel below. Opponents noted that the cost of Dabhol was dramatically higher than the existing electricity tariffs as illustrated in the right panel below.



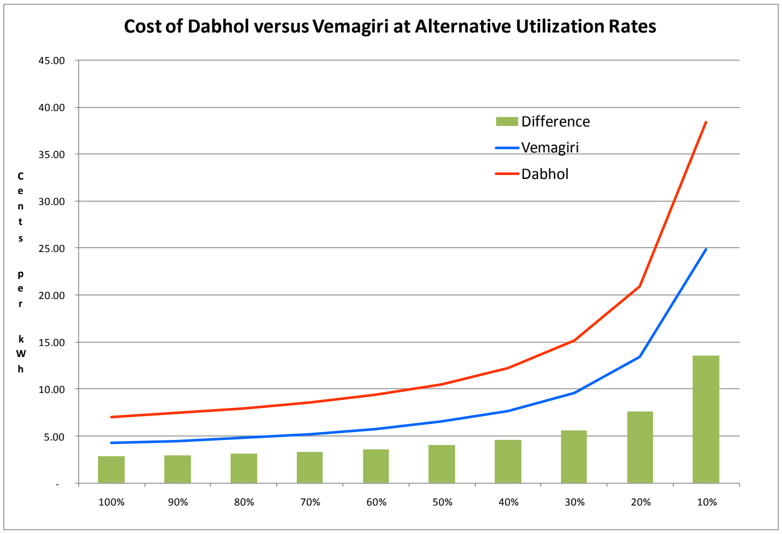


In making cost comparisons for purposes of valuation a good approach is to search for data on as similar projects as possible and account for the variable and fixed cost structure of the investment. In the graph above that was suggested by Enron as a basis for evaluating the cost of Dabhol, some of the plants were not competed and some were coal plants. On the other hand, the comparison of Dabhol tariffs for generation of electricity with the subsidized rates for distribution, transmission and generation of electricity that were aging is also not relevant to measuring the cost of new capacity. One power plant that is more comparable is a natural gas fired plant named Vemagiri built in the neighboring State of Andhra Pardesh. This plant had a capital cost that was about 50% of the cost of Dabhol -- the cost per kW was $741/kW for Vemagiri while it was about $1,400/kW for Dabhol. Both Dabhol and Vemagiri used similar combined cycle technology. The graph below shows the rate of return realized on equity using rates that recover the cost of capacity in the Dabhol contract assuming various different plant costs (the plant costs per kW are shown on the x-axis and the return is shown on the y-axis.) As the plant had a cost of between $700/kW and

$800/kW, had this plant been able to receive the same capacity charge as Dabhol, its rate of return equity would have been above 60%. Thus, from a capital cost perspective, the cost of Dabhol seemed to be very high.



An economic comparison between the plants should consider all of the costs, including capital and operating costs. This can be accomplished through comparing the prices that would have to be paid by consumers at different capacity utilization percentages. If one plant has lower capital cost but higher operating cost, then at some point with high utilization the overall combined fixed and variable costs per unit produced may be lower. However, in addition to having a lower capital cost, the Vemagiri plant also had lower variable running costs than Dabhol. The graph below shows that the overall cost of Dabhol was higher than the comparison project over the spectrum of capacity factors. The bars demonstrate that the difference in the cost per unit is aggravated at low utilization rates. From this comparative analysis one can conclude that the Dabhol plant had a cost of about 55-65% above the long-run marginal cost. The Dabhol plant demonstrates that being brilliant at negotiating contacts with government agencies may seem to generate high profits, the risks of depending on prices far above marginal cost cannot ultimately not be avoided.



The previous section described how valuation of investments will eventually converge to the underlying cash flow based valuation. Similar principals apply to price variables that underlie many cash flow projections where prices are set on a reasonably competitive basis. In this case, rather than values not being able to deviate indefinitely from the risk adjusted cash flows, the prices cannot deviate from long-run cost of production indefinitely. As with valuations, the prices may deviate by large margins and for relatively long periods. However, as long as there is some semblance of competition, then new entry and demand growth drive prices toward marginal cost. As with valuations that are derived on some other basis, when analysts say that a price variable such as the oil price is high because investors are looking for a place to put their money, the argument sounds persusave, but it does not stand up. In this case, if the price was higher than cost, one would lose money if one were to hold the oil. However, as long as the storage costs are not high, the current price should reflect the future price, because if the price was expected to increase, then one would hold current stocks.

Do not have to be expert in extremely precise estimates, but must understand how prices can move in the long-term. This leads to cyclicality in prices that is so often missed as analysts who pay undue attention to recent trends. Refer to chapters on forward price and marginal cost. Discussion by television analysts refers generally to supply and demand. Instead, understand cost curves and long-run marginal cost. Of course, actual prices may never attain the long-term marginal cost level. In the short-run prices can deviate from long-run marginal cost by wide margins. The volatility in prices is driven by changes in inventory and the ability to store, changes in variable cost, temporary capacity shortages, collusion and many other factors.

In valuing assets, the potential for prices to deviate form the long-run cost (required to sustain IRR equal to the WACC) must be considered. In particular, if prices will be driven below cost during the beginning of the project operation the value may detoriate by a wide margin. The limits on price are driven by short run marginal cost in the downward direction and the cost of customers finding alternatives on the high side. Inelastic demand drives price spikes while the ability to store things in inventory limits price volatility.

Chapter 6

Kittyhawk Air Freight Merger – Interpretation of Multiples and Expected Returns

Conceptual Valuation Errors Made in the Case

The case study described in this chapter addresses corporate finance rather than project finance issues and involves debt and equity analysis of a merger. As with Petrozuata, this case is old and the result is known. Also, as in the case of Petrozuata, the end did not turn out well. The way you can think about corporate finance which contrasts with corporate finance is to contrast the amorous relationship analogy discussed in Chapter 3 with a family or a city. The relationship discussed in project finance had a defined beginning, when the first development expenditures or money for dinner dates was made. In the case of a city, a family or a corporation, such a beginning is not so easy to identify. The city of Detroit began at some time when Native Americans inhabited the area and BMW Corporation also began a long time ago as did your family. Whereas the amorous relationship or project finance has no history, the corporation does have a history. In studying the prospects for your family or the City of Detroit it would be a big mistake not to understand its history. For a corporation, the history can be understood by examining financial statements and making some sort of statistical analysis of the numbers. When projecting the future for your family and potential ups and downs it may experience, you must also understand the strengths and weaknesses of different children, parents and grandparents as well as the external environment in which the family lives. As the family, the city and the corporation does not have a definitive end, the future prospects cannot be evaluated over its entire remaining life. This is unlike the project finance where the assessment of the project success ends when the relationship is ends, as all do. This little comparison is intended to point out that in corporate finance you must study history and come up with some way to value an indefinite life.

The first case study addressing value in corporate finance involves a freight airline company named Kitty Hawk, Incorporated. Kitty Hawk was founded in 1978 by Thomas Christopher and is based in Dallas. It completed an initial public in early 1996 at a stock price of $12. Stock analysts following the company touted its innovation and efficiency. After the IPO, Kitty Hawk's stock price increased to $18.5 in 1997 driven in large part by expectations of high growth. In September of 1997 Kitty Hawk acquired another company that was larger than itself. The merger was financed with a complex mixture of debt and shares through a second public offering. Within a few years merged company's cash flow declined and it could not repay its debt.

offering and a merger, Kitty Hawk . Introduce different between project finance and corporate finance. In corporate finance IRR's, DSCR's and LLCR's are not used as in the previous two chapters. Instead, multiples such and P/E, price to book and EV to EBITDA are used in valuation while ratios such as debt to capital, debt to EBITDA and interest coverage are used in assessing credit quality. The issue described in this case involves how this ratios can be misinterpreted and used in a manner that does not reflect underlying economics of the company. The case study involves a relatively small company that owned ___ Boeing 727's (revenues of __ and market capitalization of _____) named Kittyhawk. The company was in the airfreight business. After an initial public offering it acquired a larger company that owned a larger and more diverse fleet of planes named Kalitta. A couple years after the merger Kittyhawk declared bankruptcy.

The case study of Kittyhawk illustrates the importance of understanding valuation multiples and credit ratios. As with the last case, it also demonstrates the importance of bankers developing a reasonable downside case. Unlike other cases, the source of information is not HBS cases, but rather original financial statements and prospectuses. Errors that led to problematic valuations and credit analysis of Kittyhawk included:

- Not beginning analysis by assessing competitive position of the company through consideration of ability to earn returns and grow.
- Assessing valuation with multiples from comparative samples that are biased and do not reflect the underlying fundamentals of the company in question.
- Not determining which financial ratio is most appropriate in analyzing the value of corporations and over-emphasis on EPS growth.
- Interpreting stable P/E ratios in industries where earning returns above the cost of capital over the long-term.
- Choosing the wrong multiples in assessing whether reasonable amounts are paid for an acquisition.

- Attempts to use Debt to EBITDA, Debt to Capital and EBIT to Interest in measuring credit quality.
- Importance in understanding potential maintenance capital expenditures when making forecasts for assessing credit quality.

Synopsis of the Case

Kitty Hawk was a small freight airline company that earned __% of its EBITDA from logistics and ___% of its EBITDA from moving air freight before it completed an IPO in 1996. The company had owned ___ planes, consisting of ___, ___ and ____. The company had been profitable, earning a return on equity of ___% and experiencing growth in revenues of ___%. As the IPO allowed the company to raise stock, it could purchase the necessary airplanes to continue growth of its business. Before the IPO, __% of its shares were owned by ____.

Time line with IPO, Merger, Warnings and Bankruptcy

After the IPO had 10.5 million of shares. Target stock price of 1.45 EPS x 12 P/E resulted in 17 share price. The 1.45 EPS is from the company guidance for 1998 and is 15% CAGR above the 1996 fiscal EPS of .55. Estimated ROE in 1998 was 19%. Debt was only 16%. Scott Stringfellow had estimate of 1.45 and P/E ratio of 13.5 to 14 giving a price of 20.

Before the merger, Kitty Hawk owned 25 planes, 17 of which had contracts. Other was spot, that the company terms on demand.

Forecasts made by growing air freight business. Must buy planes and pay from internal cash flow. If cost of planes increase or if market changes or if margins change because of increased expenses, the EPS cannot be met.

Beta irrelevant. Risk is high with high growth. New businesses and no contracts.

Merger was in September 1997. Issued new shares of 4.1 Million. Also issued debt of $340 million. 1.1 million shares go to Kalitta.

Easy to get confused by all of the jargon and accounting adjustments in a merger. Share exchange, accretion and dilution,

Comes down to how much paid and

Begin by understanding the sources and uses of funds.

Analysts who covered Kitty Hawk and were involved in the IPO touted growth prospects and the strong returns of the company. Earnings per share were projected to grow from ___ to ___. rough selling stock company was positioned to had a small logistics business and some small airplanes. The

First discuss the initial public offering and valuation of the shares. How made a valuation with the P/E ratio and how made a forecast of earnings per share.

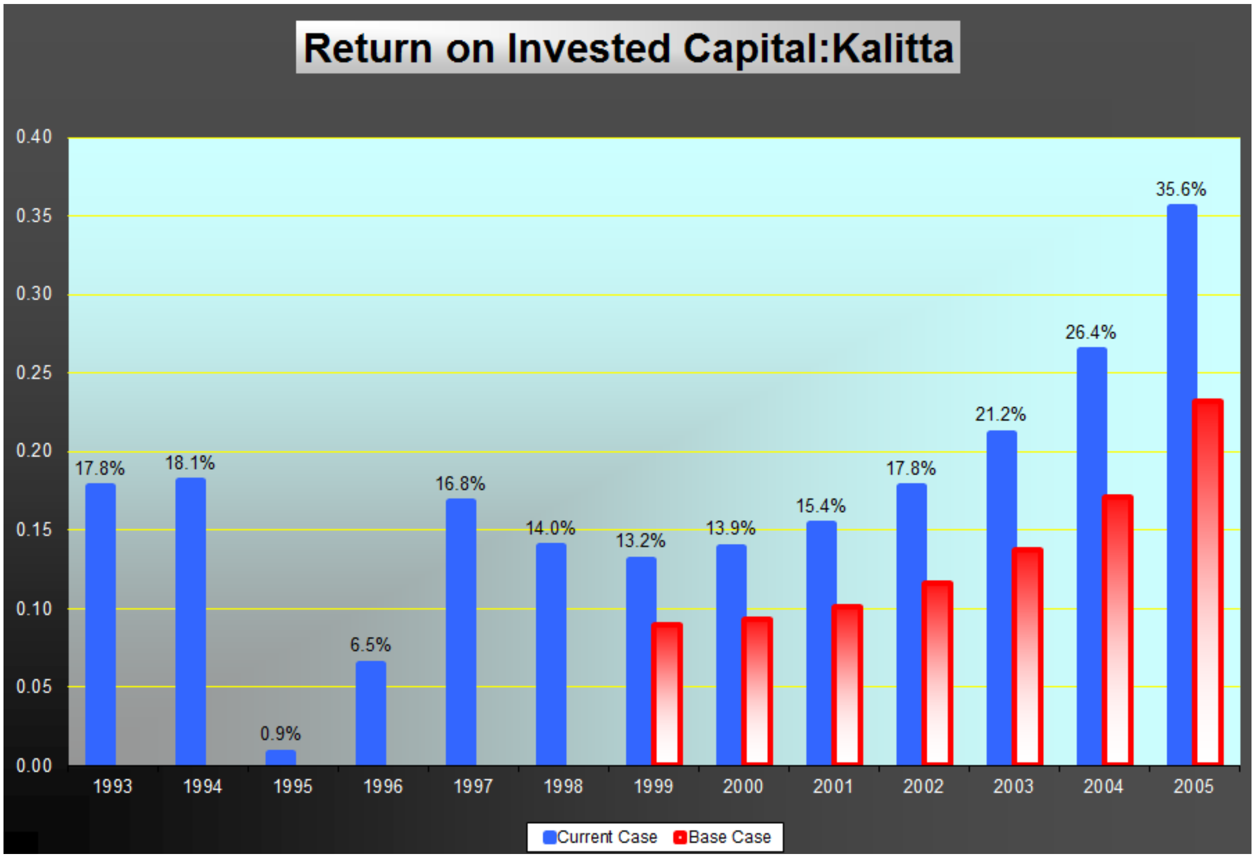
Background on Kittyhawk. The The Company's strategy is to continue its rapid growth by:

(i) acquiring additional Boeing 727-200 aircraft primarily for its ACMI contract business to meet expected growth in air freight transportation demand in both the North American and Pacific Rim markets,

(ii) increasing its focus on marketing to firms reducing inventory and shortening product cycle times through direct air shipments from manufacturer to end user,

(iii) continuing to provide high quality service through the ongoing development and enhancement of its computerized database, information software, and tracking systems, and

(iv) pursuing the acquisition of domestic and international strategic suppliers of on-demand air and related ground transportation services.


Return on Invested Capital:Kalitta
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
17.8%
18.1%
0.9%
6.5%
16.8%
14.0%
13.2%
13.9%
15.4%
17.8%
21.2%
26.4%
35.6%
1993
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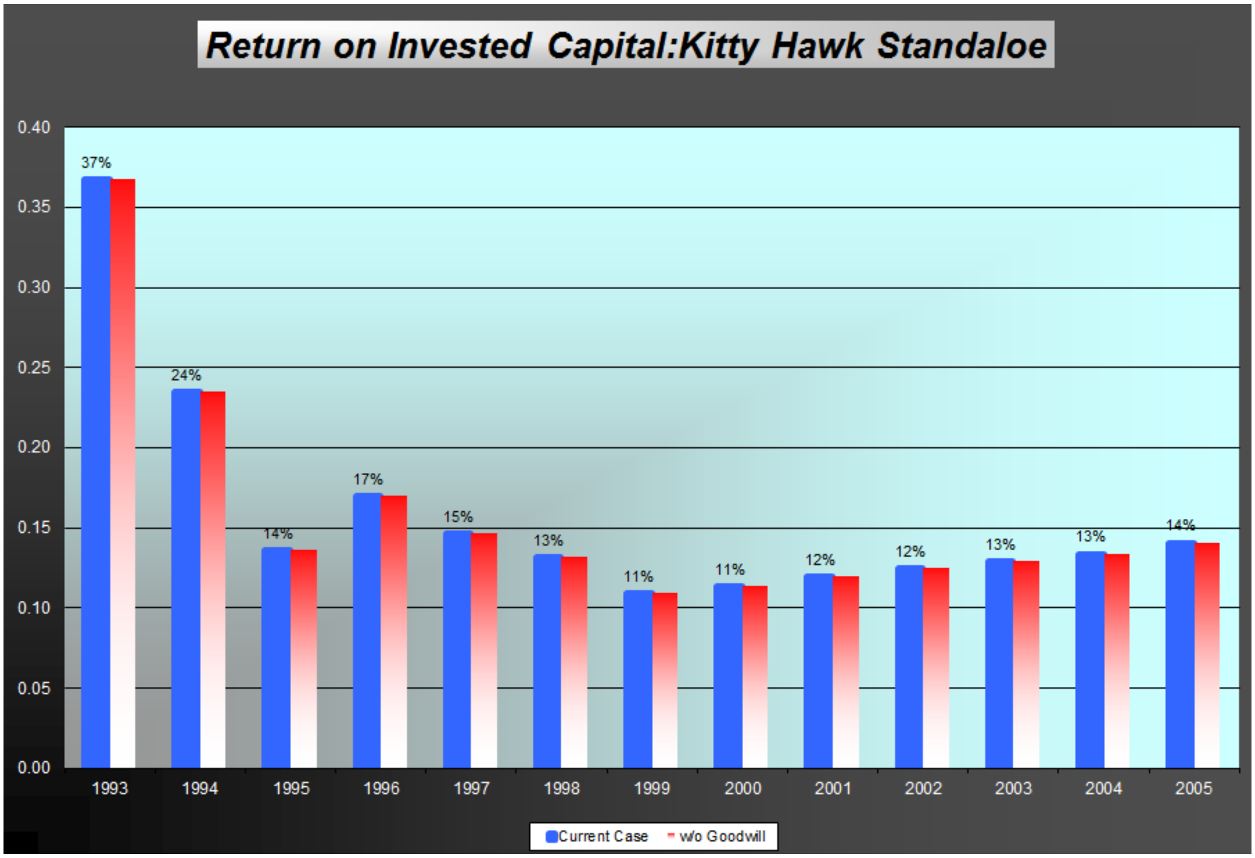
Base Case



Return on Invested Capital:Kitty Hawk Standaloe
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
37%
24%
14%
17%
15%
13%
11%
11%
12%
12%
13%
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1999
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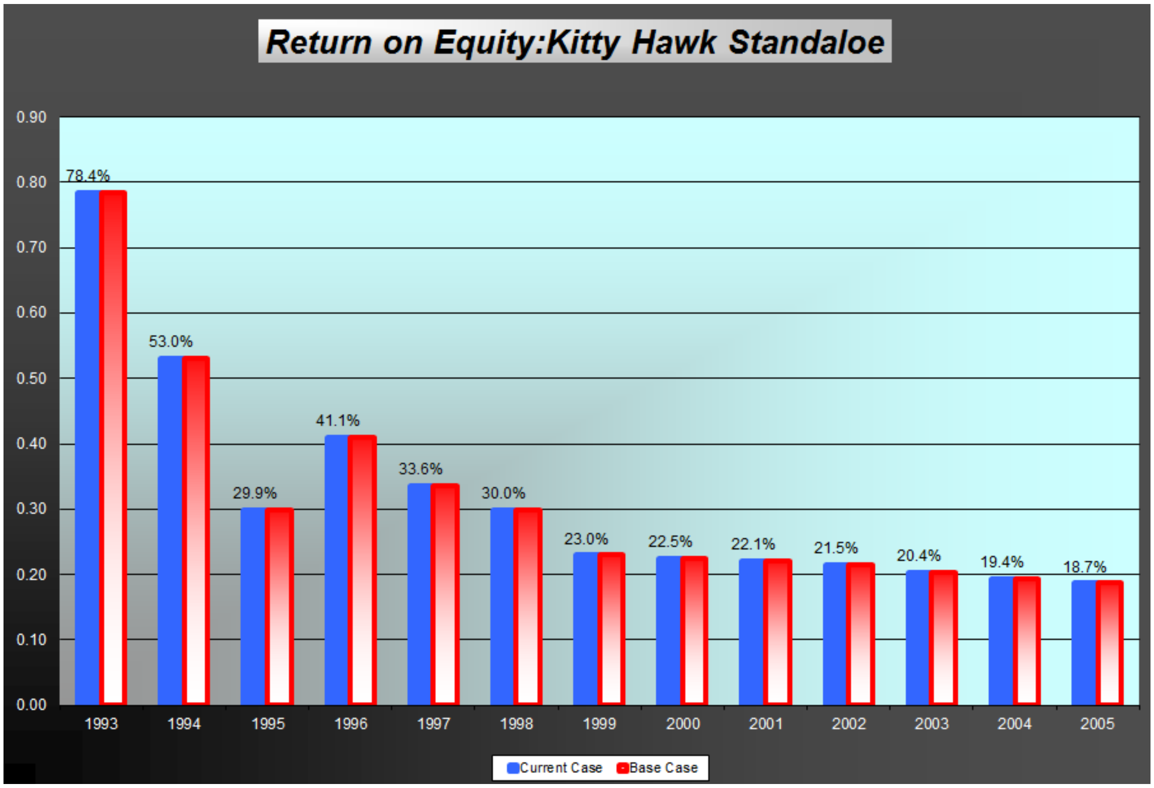
2001
2002
2003
2004
2005
Current Case
w/o Goodwill



The Company's full-time staff of five computer programmers intends to continue developing systems and software to enhance productivity, knowledge, and customer service. The Company has developed and is testing an Internet system to provide its account managers with real-time updates on available third party on-demand air charter aircraft across North America.

The Company believes that this system will enable it to meet customer demands more efficiently and quickly in the future. In addition, Kitty Hawk is working to enhance communication between its flight managers and flight crews by utilizing laptop computers with communications software that will enable the Company to quickly exchange operating data between Company headquarters and an aircraft, including while such aircraft is airborne.

By increasing speed and reliability of communications through the use of these laptop computers, the Company believes it can reduce telecommunications and labor costs. Finally, Kitty Hawk intends to provide its maintenance and flight crews with on-line access to the latest operating and maintenance manuals stored on CD-ROMs.

Valuation Issues in the Kitty Hawk Case

Valuation Issue 1 – Beginning Corporate Analysis by Understanding Business Fundamentals

Valuation of corporations can use history. If the risks and the profit prospects of a company remain relatively stable and growth is reasonably predictable then the value should be predictable. Recall the four square matrix shown in Figure 2.4 that included rate of return, growth and cost of capital. The drivers of value are the rate of return, the growth rate and the cost of capital that measures risk perceptions, inflation expectations and the real cost of capital. If the growth and return are stable, then valuation changes as the required return varies. Changes in the rate of return can implicitly be derived from three financial ratios including the P/E ratio, the EV/EBITDA ratio and the price to book ratio. Instead of making futile attempts to measure the cost of capital – the subject of the Part 2 – you can use the multiples to gauge the company value. If growth and return stay constant, then P/E ratios, EV/EBITDA ratios and price to book ratios should increase when risk perceptions decrease and/or when the real cost of capital declines. For the case of Kitty Hawk this would imply that to check the reasonableness of valuation one can examine other companies with similar risks, returns and growth prospects. These should be in the same industry.

For Kitty Hawk this was the method of valuation. Earnings were to grow and valuation of those earnings was made on the basis of the P/E ratio. For example, if you paid $12 for a share at the date of the IPO and earnings were to grow to 1.45 as expected, the value could be estimated by multiplying the EPS by the stock price. From the 1996 level of .55, the growth rate over three years was to be ___%. Returns could be estimated from the ROE and the book value.

Problem are that the P/E may be completely wrong from other companies. Can vary a whole lot. More problems were that the risk of the company was changing dramatically. Company was becoming a carrier instead of logistics. Growth meant there were not contracts with fixed prices. Both the returns and the risks were changing dramatically. Could not compare to other companies with monopoly type profits such as Federal Express.

Instead of simple historic analysis, must assess the

Sensitivity to returns. If could not earn, could not grow without raising more shares. In commodity industry where there were a lot more old plandes coming to the market, the There are many problems with this type of relative

analysis as well as benefits. If a company's risk is different and its return prospects are different. The analysis does not work. Where the money comes from. Logistics cannot grow. Air Freight was very competitive business. New revenues must come from on-demand business. More sensitive to which is more subject to competitive pressures.

Valuation Issue 2 – Using Relative Valuation to Assess Value and Credit Analysis

In making valuations, there is a reasonable desire to compare one company with others when establishing value. Define relative versus fundamental value. Problem in making relevant comparisons. Multiples are driven by growth and return. Comparisons should have similar implications. Cannot apply simple valuations.

Why multiples can be good compared to WACC and long-term growth see Part 2. First problem is samples. Second problem is what happens to multiples over time. Theory is that they are influenced by the same thing.

Valuation Issue 3 – Assessing Corporate Acquisitions with High Market to Book Ratios are Reasonable for Asset Heavy Industries Subject to Competitive Pressure can be Far Above 1.0

In evaluating the acquisition of Kalitta, a couple of questions immediately arise. First, Kallita was on the verge of bankruptcy and possibly could have been purchased directly from lenders. Second, as the transaction was complex in that Kalitta was paid cash for planes before the final transaction, paid shares of Kitty Hawk and paid in cash. In making valuations, there is a reasonable desire to compare one company with others when establishing value. Define relative versus fundamental value.

Valuation Issue 3 – Use of P/E Ratios that do not Reflect the Long-term Earnings Potential of a Company Relative to the Cost of Capital

Valuation Issue 4 – Use of Debt/EBITDA and Similar Ratios in Credit Analysis with Potential Maintenance Expenditures

Chapter 5

Taking on Risk and then Trying to Hide it - the Case of Constellation Energy

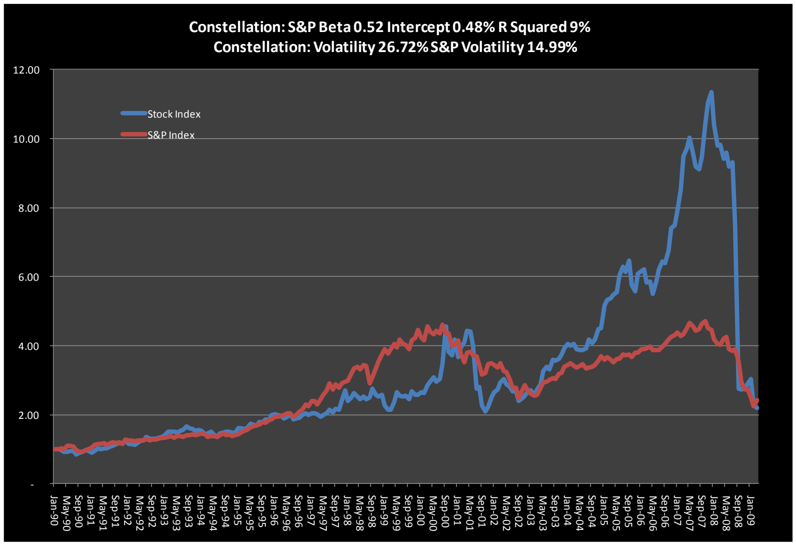
Conceptual Valuation Errors Made in the Case

This case study addresses the importance of using appropriate information when evaluating the relation between the earned rates of return and the risk of cash flow variation as well as problems that occur when valuing an investment using multiples or discounted cash flow. The case used to demonstrate this problem is Constellation Energy, a company that experienced a dramatic decline in stock price on the day after Lehman Brothers declared bankruptcy in September 2008. Through swallowing confusing presentations by management without working through where sources of cash flow and by not correctly considering risks of the business, the company was dramatically overvalued in the boom period before the crisis. Management had attempted to manage earnings growth and stock value through entering businesses in which it had no competitive advantage and hiding trading risks it was taking on by presenting financial reports in an opaque manner which did not delineate cash flow from its different business activities. The lack of transparency apparently prevented analysts from developing effective financial models of the cash flow, assessing risk and using appropriate valuation multiples such as the P/E ratio and the EV/EBITDA ratio when valuing the company. As

the true risks that the company was taking became apparent during the months of turbulent energy prices and stock prices in the autumn of 2008, its stock value plummeted dramatically.

Synopsis of the Case

Changes in the value of Constellation are demonstrated by comparing the years 2006 through 2008 for the company. 2006 and 2007 were good years for Constellation Energy from a financial standpoint. Its stock price rose from $57 per share at the beginning of the 2006 to $103 at December 31st of 2007. Including dividends, the growth in cash flow to investors over the two years was 78%. Times were also good for Constellation's CEO, Mao Shattuck, a former investment banker at Deutchebank as he earned compensation of $12 million. 2008 was a different story. The company's stock price fell to $13 per share in intraday trading on September 16th – the day after the Lehman Brothers collapse. By March 2009, the stock price had settled at about $18 per share. In terms of total market value, Constellation investor losses were $16.5 billion – falling from a market capitalization of $18.8 billion (share price multiplied by the number of shares) all the way down to $2.3 billion. In attempting to maintain value, Shattuck made a decision to merge with MidAmerican Energy on an expedited basis. A couple of months later he cancelled the transaction, costing shareholders more than $2 billion in fees and stock dilution, representing 45% of the total merger offer. Constellation finally entered into a transaction with EDF Development Inc. (a subsidiary of Electricite de France) but its stock price has remained low. The dramatic change of Constellation's stock price is illustrated by the graph of its stock price compared to the S&P 500 below. The question addressed in evaluating this case is what if anything was wrong with the valuation before the crisis and whether the crash in stock prices reflected the true value or whether it was just panic that had little to do with fundamental value.



Studying Constellation Energy illustrates the type general type of valuation errors that led to a fall in stock prices of 53% during the financial crisis (from August 2008 to March 2009) as well as the inappropriate application of valuation multiples and value at risk statistics in valuation and risk assessment. A few months before the crisis, Constellation presented an analysis demonstrating that its value should range from ___ to ___ as shown in the table below. After the stock collapsed, Morgan Stanley made a similar analysis suggesting the value was only ranged from ___ to ___ which is presented alongside the Constellation analysis. Both valuations could not be correct. Evaluating what was wrong with the analysis in this extreme case allows one to see general problems that occur with the way valuations are made in practice. The case involves delving into the type of analysis that was made before the financial crisis that led to unrealistic valuations in a detailed manner. This contrasts with vague statements about over-leverage, overly complex financial instruments or lack of transparency.

When considering the dramatic changes in valuation of Constellation, one can start with the basic concept that the underlying value of any business enterprise comes from competitive advantage and the ability to produce more benefits to owners than the investors could realize from other investments – earning a return above the cost of capital. (Chapter 4 Appendix) In order to earn returns above the cost of capital, a business must create some kind of sustainable competitive advantage. This competitive advantage may come from efficient cost structures, innovative products, superior investment timing or monopoly power. When a company suggests that it can earn extraordinary profits without doing

anything special, such as speculative trading, selling credit default swaps, or buying business that are fundamentally unrelated to its historical skills, you should step back and ask the question what makes the company unique. Multiples such as the P/E ratio come from the ability of a company to earn a return above its cost of capital and grow a business. If the multiples obtain high levels without both competitive advantage and growth, the ratios may be dangerously high. For example, the P/E multiple should be quite different for trading operations than for a power plant that receives revenues from fixed power contracts.

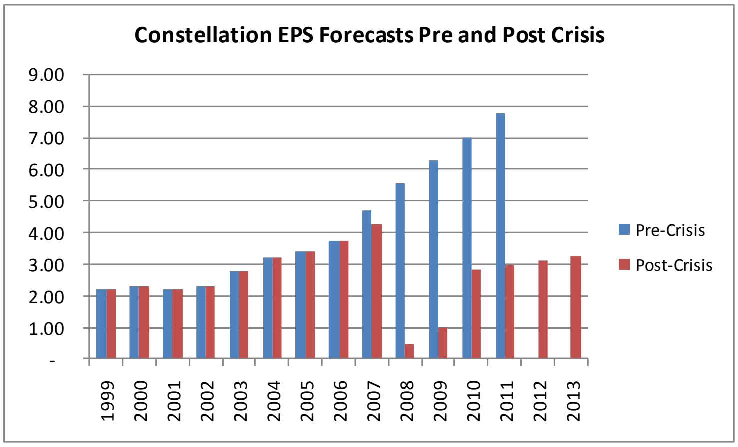
To understand the valuation of Constellation Energy, one can look at the stock prices prior to 2006 which were unremarkable compared to companies engaged in similar activities. According to Mao Shattuck, Constellation's CEO, the company has been "laser focused" on increasing its stock price. Generating earnings growth with existing businesses was difficult for the Company because Constellation purchased three nuclear plants at premium prices in New York that came along with fixed price power contracts (as with many descriptions of its business activities, Constellation used language that sounded sophisticated and did not call them contracts. Instead it used the phrase "below market hedges" implying that the company had somehow use energy trading strategies to reduce risk). In terms of return, Constellation lagged behind its peers who were earning high returns from the transition to deregulated rates as shown in the table below. Mao Shattuck's solution to the divergence in returns was to expand speculative trading and purchase companies that could produce near term earnings with increasing energy prices.

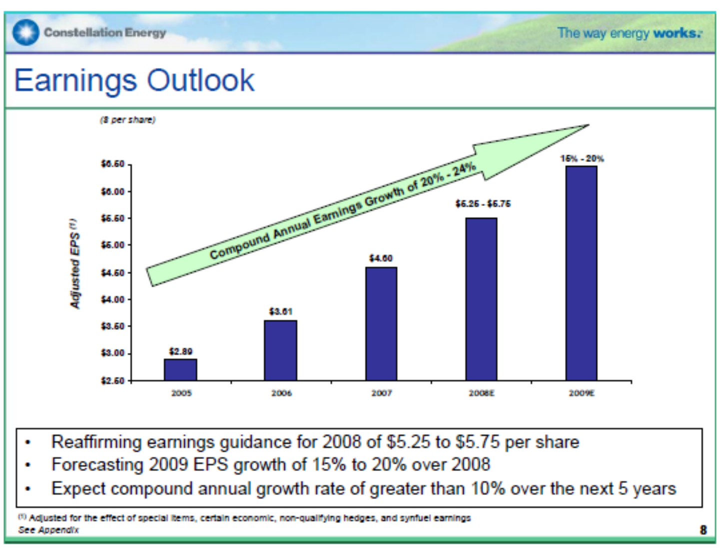
Return on Equity Reported by Value Line

	2001	2002	2003	2004	2005	2006	2007	2008
Exelon	17.20%	20.10%	18.80%	19.50%	23.60%	23.70%	26.90%	24.60%
PSEG	18.60%	18.60%	18.60%	18.60%	18.60%	18.60%	18.60%	18.60%
PPL	20.80%	18.10%	20.20%	16.10%	16.50%	17.30%	18.20%	18.20%
Constellation Energy	**9.20%**	**9.30%**	**11.10%**	**11.70%**	**12.30%**	**14.80%**	**14.70%**	**2.60%**

The strategy seemed to work as shown by the earnings per share projections before the crisis presented on the graph below. This is shown in the graph below which demonstrates the earnings per share projections before and after the crisis. Before the crisis, Constellation's P/E ratio reached 20.1 because of the expected earnings per share increase. Earnings projections by investment analysts were in large part driven by the guidance provided by management as presented in the second graph below. The company had consistently met or exceeded the earnings

projections which seemed to give analysts confidence about the future earnings, even though it was very difficult to verify exactly where the future earnings were to come from. The manner in which the earnings projections typically translate into expected prices and returns is typically multiplying the expected earnings by a future assumed P/E ratio as illustrated below. This is analogous to a discounted cash flow model where an explicit period of cash flow is modeled and then a terminal value is computed using multiples such as the P/E ratio or the EV/EBITDA ratio.





While the return on equity of Constellation Energy was lower than its peers, the company was able to increase earnings per share through growing something it ultimately named its commodities business (this was not named and segregated as a separate item in financial reports until 2008 when the stock price began to fall). By contrast, the peer companies shown in the table above were primarily in the business of selling electricity from merchant generating plants and operating regulated distribution companies. As shown in the table below (which was not published until the stock price was crashing in 2009), Constellation's earnings in 2007 and 2007 almost fifty percent of its earnings were comprised of trading related businesses named customer supply and global commodities. The company bought ships that transported coal and used the sophisticated but confusing phrase named "freight intermediation." Constellation purchased about $1 billion of oil and gas producing properties and named them "energy related assets." It explained the purchases with the puzzling logic that: "As a merchant supplier [of electricity], we are able to identify opportunities to serve customers, which provides the insight to acquire assets and deploy risk capital at the right time." Finally, Constellation often used the term that it "deploys risk capital in traded energy markets" to describe its trading business, which apparently meant speculating on energy prices. Investors ultimately found out that this meant taking speculative positions on energy prices.

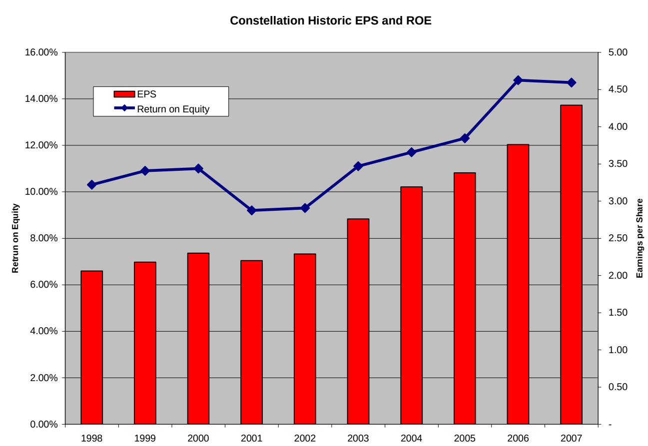
Constellation Merchant Segments Reported in 2009 ($ millions)

	2006	2007	2008
Gross margin:			
Generation	1,490	1,700	1,956
Customer Supply	764	889	765
Global Commodities	656	654	260
Total	2,910	3,243	2,981
Generation Percent	51%	52%	66%

The strategy of increasing earnings through expanding trading and buying energy assets did increase earnings as shown on the graph below, but it also caused a couple of problems for Constellation. The first problem was that trading profits were not generally valued highly by the stock market meaning that the increase in earnings would not necessarily translate into a higher stock price. It is natural for investors to value trading profits much less than profits from other activities such as selling power because if investors want to take speculative

positions in energy markets, they can do so without a corporation making trades on their behalf. For example, if an investor would like to bet on the price of electricity going up, he could buy a forward contract for a fixed price and then if the actual price exceeds the contract price, he would realize a profit. There is no reason for Constellation to be involved in this transaction and if this is all that the company is doing, investors would surely want to know. The second problem was that the trading profits had different risk characteristics and were more difficult to evaluate than cash produced by selling electricity from a plant. When discounting earnings from trading activities, the discount rate applied to these cash flows would be much higher than the discount rate applied to other activities. The problems faced by Constellation are illustrated by the following statement by Mao Schattuck suggesting that investors do not attribute enough value to the company's brilliant skills in trading and marketing30:

…the [commodities and marketing] businesses that had grown so fast and that had created so much earnings power had reached the point where they constituted close to 40% of the earnings power of the company. It became apparent that investors were going to have a hard time valuing a company like ours that had a utility, had merchant generation and had a commodities business that was expanding. We … had to address the issue of … whether earnings coming from the commodities group would … add no value to the shareholders worth.



Constellation would surely not admit it, but management essentially attempted to solve the above two problems by obfuscating reporting of its historic

[30] Tom Brooks, Deutsche Bank Conference, May 2008

financial results and presenting earnings projection guidance in a confusing and opaque manner. Indeed, the Constellation case can be used to define what being non-transparent really means and how incentives to be opaque with information are directly related to engaging in business activities that do not produce true value. Constellation's financial strategy was demonstrated by not presenting marketing or trading profits on a segregated basis in its financial reports; asserting that trading activities were not speculative, but instead were simply being used to hedge other activities; showing how smart the management is by using terms in investor presentations that were so confusing as to require a translator; presenting confusing risk exposure statistics; and making aggressive earnings forecasts without explaining value drivers. Because cash flows for different segments of the company were not presented in a transparent manner, analysts who attempted to value the company could not separate cash flows earned from the speculative trading activities from cash flows associated with the generating plants and the analysts could not apply different risk premiums and multiples to the different businesses.

The first aspect of transparency involves presentation of Constellation's financial statements. The problem was not that assets were hidden in special purpose vehicles, but that cash flows from different businesses were mixed together. Before 2008, investors had no way to differentiate between the safe and stable profits made from selling power from one of its nuclear plants under fixed price purchased power contracts from the profits made by speculating on the direction of energy prices. The volatility of cash flows, cash flow drivers and trends in future cash flow were different for each business segment and the historic data was useless in making valuations. Constellation was hoping that the aggregate cash flows would be valued at the price to earnings and other multiples of peer companies that had safer businesses. As a contrast to Constellation's reporting, another company named NRG Energy reports the amount of projected revenues under contract, the revenues earned from trading profits and the revenues earned from spot sales in each region that it operates. The contrast with Constellation is stark. Not surprisingly, investors had been complaining about Constellation's transparency in reporting its results for years as illustrated by the following talk given by the company's chief financial officer:

We continue to hear from you regarding the transparency of our business and our overall disclosure…[In] improving transparency … we will be working towards discrete reporting on each business unit to provide more detailed information on segments currently reported. As you are aware, in 2008, we refined our reporting to show gross margin by activity…

Lack of transparency for Constellation was not limited to its financial presentation. The second aspect of its opaque presentation was the manner in which Constellation explained its businesses to investors. Language used by Constellation is a good example of the way finance professionals attempt to create confusion though showing how smart they are. In earnings conference calls and other presentations, Constellation would use phrases such as “asymmetric collateral requirements”, “deployment of risk capital”, “leveraging business platforms”, “as priced margins”, “transitional liquidity”, “right-sizing of strategic footprints” and many others. The general idea of the presentations seemed to be that investors should trust the superior qualities of the company and not worry about risks in the business ad illustrated by the following statement made by Mao Schattuck: “the realignment of all our merchant businesses allows us to leverage our world class capabilities in risk management and portfolio management across our industry-leading platform.” When listening to Mao Schattuk and other Constellation managers, if you are impressed by confusing financial terms, you would think they really were very smart. Listening to Constellation management before the collapse, it was easy to feel quite inferior to their superior intellect.

A third component of non-transparency was the way in which Constellation belittled its exposure to potential losses from its trading activities by emphasizing that most of its trading was for hedging activities related to its merchant plants; for hedging for customers; and, hedging its coal business. The chairman of Constellation never directly admitted that the company had been engaging in speculation until he discussed the transaction with EDF in December 2008, when he discussed “taking positions.” Implications that the company was not significantly betting on energy price movements were contrary to other statements made by Constellation and the volatility in its financial results. For example, management stated that it was bullish on energy prices in its second quarter 2008 conference call. One of the company executives reported: “…we entered the second quarter bullish on energy commodities …” If Constellation was simply hedging its positions, it would be neither “bullish” nor “bearish” on energy prices. In fact, Constellation was profiting from the long bubble in energy prices similar to the way many companies and people were profiting from the housing price bubble. While energy prices were increasing, it was easy to be confident in the trading strategies that were producing profits. After all, when crude oil prices reached $147 per barrel in the summer of 2008, almost everybody seemed to believe that oil prices would soon reach $200 per barrel.

A fourth way in which Constellation was non-transparent was in the way it presented risk using complex mathematical statistics that could not be verified. The company regularly reports “value at risk,” a complicated statistic that

supposedly measures the maximum loss that could be realized in one day with a one percent probability. In the third quarter of 2008, the value at risk number was about $30 million. This compares to the actual decline in earnings for the commodities business of $634 million. Dividing $634 by $30 implies there were as many as 21 days of one percent likelihood events. With hindsight, the value at risk statistic was meaningless for risk assessment and it would have been for more useful to simply show what happens to cash flow and earnings at different levels of commodity price or to present a series of scenarios with different commodity prices. Further, in providing earnings projections to investors, the company did not show components of the forecasts and explain how much of the projected earnings increase was due to selling electric power and how much was from marketing and trading. To demonstrate the lack of information in earnings guidance, in the middle of 2008, Constellation earnings guidance for 2009 was about $6.00/share. A couple of weeks later it was as low as $1.50/share.

Once it became apparent that Constellation was taking making speculative bets and did not have the cash on hand available to keep trading, the investors and management panicked, ultimately resulting in the above referenced merger with Warren Buffet's MidAmerican Energy with extremely onerous terms. The table below illustrates that the credit spreads for Constellation exceeded the spread of Lehman Brothers before the bankruptcy of Lehman. Credit spreads measure the likelihood of bankruptcy and the possibility of recovering debt after bankruptcy. (Chapter 4) The fact that Constellation debt would require a spread of more than 7% suggested that the market believed bankruptcy was a very high possibility, even though the company still had an investment grade bond rating.

Credit Default Swap Spreads

	1 Year Prior	6 Months Prior	3 Months Prior	1 Month Prior	17-Sep-08	18-Sep-08
Exelon Generation	0.638%	1.702%	1.138%	1.353%	2.292%	2.392%
Exelon Corp.	0.608%	1.512%	1.002%	1.235%	1.925%	2.162%
PPL ES	0.595%	1.888%	1.152%	1.491%	2.817%	2.617%
PSEG Power	0.492%	1.664%	0.999%	1.282%	2.383%	2.471%
IG10 Index	0.610%	1.850%	1.120%	1.344%	2.034%	1.787%
Lehman	0.925%	4.433%	2.528%	3.043%	7.067%	7.067%
Constellation	**0.528%**	**1.793%**	**1.017%**	**1.818%**	**7.650%**	**2.808%**

The specific reason for Constellation's ultimate financial demise was panic in the financial community that the company could not raise enough cash from lenders provide back-up loans so that it would have collateral to continue its trading activities. If the company were downgraded to below investment grade, these requirements for back-up loans and cash would be magnified. Constellation management defined its finance collapse as a "liquidity crisis" and attributed it to events that were beyond its control -- on "unprecedented turmoil in financial

markets," "volatile energy commodity prices" and the actions of rating agencies who were worried about trading partners losing confidence. The downfall began when rating agencies finally recognized (after the fact as was the case for so many other credits) that Constellation had more risks than its peers – the downgrade occurred after energy prices had began to fall. For example, the rating agency Fitch, noted Constellation's exposure to energy prices, implying that it was taking positions in its trading: "Constellation … is exposed to risks surrounding market price, volumes, counterparty credit, and liquidity for collateral." When the company places blame on volatile financial markets for its failure, it is like investors in sub-prime mortgages blaming the fall in housing prices. It is not appropriate to term Constellation as a victim of the financial crisis.

The Constellation story raises a number of valuation issues in the context of an on-going corporation. First, in a case where a company owns a few diverse businesses, use of price to earning multiples can be difficult to apply because of different risks in different business segments. The utility company, being a low growth and low risk company is relatively easy to value. The brokering and global commodities businesses can be attributed little or no value. This leaves the generation segment which depends on the volatile price of electricity and assumptions with respect to long-term cash flow and discount rates. The surprising part of the story of Constellation is not that the price collapsed, but that its valuation had increased so much without understanding the source and risks of underlying cash flows. The case shows that when valuing a company, being able to quantify the risks of business components with a relatively simple financial model is a lot more important than believing fancy words of management. Constellation's collapse also demonstrates that reliance on stable earnings growth is dangerous, particularly if it encourages management to take excessive risks. Finally, the study of Constellation illustrates that growth in earnings is only valuable to the extent that returns are more than the cost of capital. If a company simply makes investments in treasury bonds and grows cash flows through buying more and more bonds, it may grow earnings but this does not create value. Similarly, when Constellation increased earnings through making risky trades, it may have increased earnings, but it also increased risk and cost of capital. As with the treasury bond example, no value was added.

Constellation's demise and the collapse of Enron contained many similarities involving transparency and strategies designed to increase earnings without true competitive advantage. Enron created virtual assets with contracts, brokered power in competitive markets, built power plants with government contracts that should not in theory generate economic profits, created a trading website and attempted to apply its skills in trading weather, broadband space and

video rentals. There was not much true competitive advantage underneath most of these activities, but the company was able to obtain a high stock price and high multiples as measured by stock price to earnings and enterprise value to earnings before interest, depreciation and taxes (P/E and EV/EBITDA ratios.)

Chapter 7

UK Merchant Plants – Projecting Margins and Value with Potential Surplus Capacity

Conceptual Valuation Errors Made in the Case

The situation discussed in this chapter -- investment choices associated with electricity plants in the U.K. merchant market – involved underestimation of risk resulting from assuming that historic price trends would continue and that future cash flow volatility would be similar to past volatility. (The merchant market means electricity plants that sell electricity into deregulated markets rather than realizing prices from long-term contracts or from regulated prices.) The valuation mistakes associated with U.K. electricity prices caused dramatic financial distress during the years 2001 to 2003 and the particular case studied involves the largest electricity plant in Europe, the Drax plant located in Yorkshire. This plant originally constructed in the 1970's was purchased by AES in 1999 and financed with a ratio of debt to capital of 90%. AES abandoned the plant in bankruptcy four years later in 2003.

Risks of changes in trends and volatility of future prices highlight issues of whether risk can be derived from credit analysis and dangers in assuming returns substantially above the cost of capital can be earned in markets with few barriers to entry. The discussion addresses whether it is effective to use debt capacity to derive risks associated with forward price projections.

AES Drax Timeline	
AES Purchased DRAX from Innogy	15-Aug-99
NETA Replaces Pool	27-Mar-01
Fifoots Plant Placed in Receivership	1-Mar-02
Downgraded from Baa3 to B3	14-Oct-02
TXU Sells Assets to E.ON	21-Oct-02
TXU Stops Contract because of Downdrade	4-Nov-02
TXU Declares Bankruptcy	1-Nov-02
Moody's Downgraded to Caa3	7-Nov-02
Standstill Agreement with Creditors	13-Dec-02
AES Abandons Drax	1-Aug-03

The case study of U.K. power plants addresses valuation problems and risk assessment that occurred more than a decade after deregulation. References for this case include the HBS Sutton Bridge case and documents related to the financing of the AES Drax plant. After market prices crashed, virtually every plant that did not have a fixed price contract was in default. Errors that led to this disaster included:

- Using extrapolation of historic price data in measuring debt capacity and cost of capital for an oligopolistic industry where sudden changes can occur.
- Understanding the potential for prices to move to short-run marginal cost when the structure of a market changes.
- Problems in applying historic volatility when gauging risk
- Importance of developing realistic downside scenarios when performing credit analysis
- Inappropriate assumption that contracts will remain in place after the contracts become uneconomic
- Appropriate debt to capacity for industries with potentially volatile margins.
- Don’t be afraid to make a marginal cost analysis without extensive level of detail

Synopsis of the Case

The United Kingdom de-regulated its power system before any country in Continental Europe, North America or Asia in the late 1980’s after the Thatcher government passed the Electricity Act of 1989 (partly in response to the famous coal miner strikes that had occurred in the country). In the initial years after deregulation, prices to consumers fell by about 30% and electric industries in other

countries began to follow the lead of Britain.31 When the market was first established in 1990, virtually all of the formerly government owned generating capacity was divided into only three companies, two of which – National Power and PowerGen – owned power plants that were privatized, while the third was a government owned company that controlled nuclear stations. Prices were set through a bidding process along with a mechanism called an administrative uplift that was intended to compensate for capacity that was available but not used.32 Since there were only two firms in the market other than government owned nuclear plants, many argued that prices did not reflect marginal cost but rather were set in an oligopolistic manner where the companies did not act as price takers and submit bids corresponding to their own variable cost, but rather strategically withheld capacity and engaged in other tactics to keep prices high. The stability and the level of prices in the U.K. led many investors to consider building new generating plants, particularly natural gas fired combined cycle plants.

If the structure of the U.K. market remained static as an oligopoly and demand grew at a similar rate to new capacity additions, the historic stable prices and low price volatility would imply that investments could support a relatively high level of debt and implicitly have a low cost of capital. In the late 1990's many new plants were indeed built and they were often able to achieve high levels of debt financing. The table below lists power plants constructed or acquired and shows that many of the projects were financed with high levels of debt (data is not available for each plant because where bank debt is used, financial statements are not available to the public.) With hindsight, if the plants that did not have fixed price long-term power contracts (i.e. were purely merchant), they could not support the 80-90% debt ratios shown on the table.33

Count	Parent Company	Project Name/ Regio	Commercial Operation as MPP	MW	Project Typ	Project Co	Cost per M	Arrangers /Lende	Debt Rat
UK	AES	Barry	1998	220	Greenfield	$ 225.00	$ 1.023	IBJ	90.0%
UK	PowerGen	Connah's Quay Power Sta	1996	1420	Greenfield				
UK	PowerGen, ESBI	Corby	1994	400	Greenfield				
UK	InterGen	Coryton	2002	795	Greenfield	$ 465.80	$ 0.586	CSFB, SG,	70.0%
UK	PowerGen, Siemens	Cottam Development Cent	1999	400	Greenfield				
UK	Entergy	Damhead Creek	2000	800	Greenfield	$ 563.00	$ 0.704	WDR/UBS	
UK	Innogy	Didcot-B	1997	1400	Greenfield				
UK	NRG Energy, El Paso	Enfield	1999	396	Greenfield	$ 353.23	$ 0.892		
UK	Centrica	Glanford Brigg	2002	240	Acquisition				
UK	BP-Amoco, Arco	Great Yarmouth	2001	400		$ 367.65	$ 0.919	SG, ABN A	87.5%
UK	Octagon Energy	Hickleton Power Plant	2000	6	Greenfield	$ 3.79	$ 0.631		
UK	NRG Energy	Killingholme	1999	665	Acquisition	$ 664.00	$ 0.998	Bank of Am	65.0%
UK	Centrica	King's Lynn	2001	705	Acquisition				
UK	Scottish and Southern Energy	Peterhead Power Station	2000	660	Restructured	$ 333.33	$ 0.505		
UK	InterGen	Rocksavage	1998	780	Greenfield	$ 575.00	$ 0.737	CSFB	
UK	Centrica	Rooscote	2003	229	Acquisition	$ 37.50	$ 0.164		
UK	Calpine	Saltend	2001	1200	Acquisition	$ 800.00	$ 0.667	WDR	90.0%
UK	Scottish and Southern Energy,	Seabank	2001	760	Greenfield	$ 641.18	$ 0.844		
UK	Scottish Power	Shoreham	1999	400	Restructured	$ 320.00	$ 0.800		93.5%
UK	Centrica, Humber Power	Stallingborough Plant	1999	1260	Greenfield				
UK	London Power Co.	Sutton Bridge	2000	790	Greenfield	$ 793.00	$ 0.695	Merryl Lync	87.2%
UK	Enron	Teesside	1993	1875	Greenfield	$ 1,200.00	$ 0.640		

[31] Green Richard, Draining the Pool: Reforming the Pool of England and Wales, December1998.
[32] The administrative uplift was £2,000/MWH escalating with inflation. See Green Richard, "Did Electricity Generators Play Cornot: Capacity Withholding in the Electricity Pool," 6-April, 2004.
[33] ADB database.

Because of innovations in the technical efficiency of combined cycle gas plants – more electric power could be sold for the same amount of natural gas used -- profit could be realized from selling power at the historic prices which had ranged from $25/MWH to $30/MWH. The table below shows that power plants could be constructed at the -- then current -- cost estimates and realize relatively high returns of more than 15% as long as debt financing was available. The three columns in the table show the economics of a new gas fired electricity plant using three different price assumptions along with a natural gas price of ___. The columns list the equity returns with different levels of debt leverage with the three different price assumptions. Equity returns below a 15% hurdle rate are colored in red on the table. With moderate levels of debt financing, the downside risk of investing in merchant plants seemed to be limited.

Equity Price	26.50	Equity Price	24.50	Equity Price	22.50
Debt Pct	Equity IRR	Debt Pct	Equity IRR	Debt Pct	Equity IRR
0.0%	11.6%	0.0%	10.3%	0.0%	9.0%
19.2%	12.6%	19.2%	11.2%	19.2%	9.7%
37.3%	14.1%	37.3%	12.4%	37.3%	10.6%
54.5%	16.4%	54.5%	14.3%	54.5%	12.1%
62.8%	18.1%	62.8%	15.7%	62.8%	13.1%
70.8%	20.7%	70.8%	17.8%	70.8%	14.7%
78.7%	24.9%	78.7%	21.2%	78.7%	17.2%
86.4%	33.5%	86.4%	28.1%	86.4%	22.3%
93.9%	69.6%	93.9%	56.8%	93.9%	42.6%

Valuation Issue 1 – Forecasting Prices and Margins in Industries where there is Potential for Prices to Move to Short-run Marginal Cost

The first valuation issue involves understanding what you are forecasting and how much historic data can be used. When making forecasts valuing a merchant power plant, the most crucial assumption is the price of power and the price of power relative to the price of fuel used by the generation technology. Unlike predicting prices and market share in the face or changing supply conditions, for some physical risks such as wind speed, geological analysis of mining resources, solar radiation, reliability of machines or water conditions, historical analysis of statistical data can be a very good way to evaluate risks. In these cases, a reasonable probability distribution associated with historic variables can be established from the historic data. However for other variables such as the

amount of traffic on a new toll road, the cost of a new and complex technology, the price of housing, the price of electricity and many other economic variables, the nature of risk is very different. When evaluating risks for these cases, history and statistical analysis are much less effective tools in assessing future possible dispersion of cash flow.

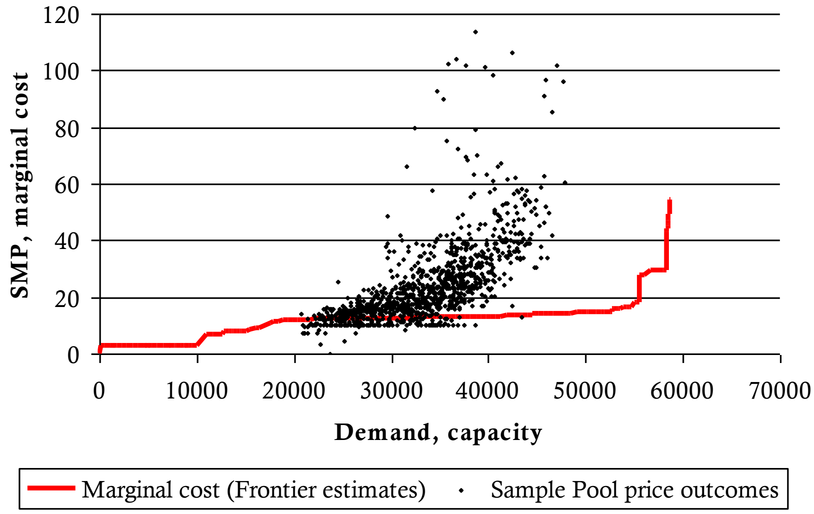
In the case of the U.K. merchant market, the underestimation of electricity price volatility and particularly evaluation of downside risk from inappropriate analysis of historic data led to incorrect cost of capital assumptions and over-investment in electricity generating capacity (analogous to the over-investment in real estate that occurred in the sub-prime crisis.) The problems in assessing risk would not have been remedied by spending more time studying beta or making a lot of sophisticated mathematical analysis with Monte Carlo simulations derived from past data. Instead, the case illustrates that understanding simple economics of market structures – specifically over-capacity and decreased concentration should be the centerpiece of analysis where the most important value driver is the risk of future market prices. With rudimentary data on capacity and demand, a model with new capacity can be developed and used to demonstrate what happens when a lot of new capacity is built. These models are demonstrated in Part 5.

Valuation Issue 2 – General Problems with Forecasting Prices and Margins in Industries that have a Changing Structure

A second valuation problem in the AES Drax case involves understanding the danger of making investments in oligopolistic industries where the competitive structure can suddenly change. Stable prices that existed in the U.K. were the result of the oligopolistic. The prices did not correspond to prices that are short-term marginal cost based prices. As with the assumption that relatively high prices and margins could be maintained in the face of increasing capacity, this assumption was also not reasonable because of political pressures and government actions. In a report on the U.K. market, Moody's noted that "the dissatisfaction with the Pool relates essentially to the scope for manipulation that generators with significant market power enjoy under the Pool's complex rules."34 The ability to exercise market power is demonstrated on the graph below which compares market clearing prices with the marginal cost of power. The prices at various levels of demand are shown on the black dots while the marginal cost at different levels of capacity is show on the red line. The preponderance of clearing price

[34] Moody's reference

being above the marginal cost is evidence that the markets were not operating in an efficient manner before U.K. markets were reformed in 2000.35



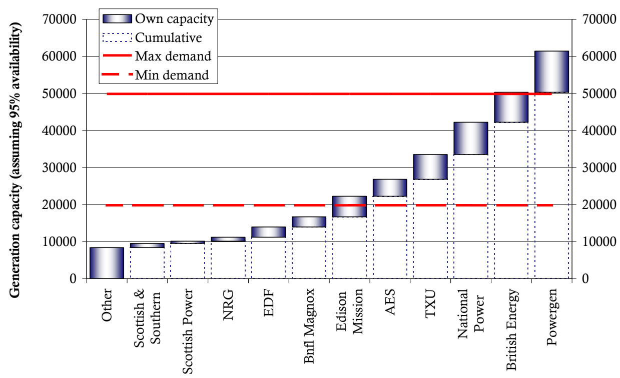
As a result of market power concerns and political outcry, the British Government dramatically changed the industry structure. It ordered the two private companies that owned many of the power plants to divest their capacity and it changed the structure of the way prices were determined in the design of the market.36 The reforms resulted in a system called the New Electricity Trading Arrangements (NETA) which was implemented in the spring of 2001 to "improve market information and transparency, enhance liquidity and reduce the opportunities for the exercise of market power by generators." 37 After reforming the market, the relative share of ownership in the market change dramatically. The difference in concentration of firms is shown in the graph below before 1999 and after 2000.38 In addition, the rules determining uplift charges, bidding, and the power pool were revised. Developers and bankers complained that the new market system changed the rules in the middle of the game and were extremely unfair to generation suppliers. However it is arguable that bankers and investors with foresight could have seen that the system in place before 1999 was not

[35] The graph is from a presentation by Philip Burns of Frontier Economics in London, October 12, 2000. "The Implications of Regulation and Competition for Corporate Activity."

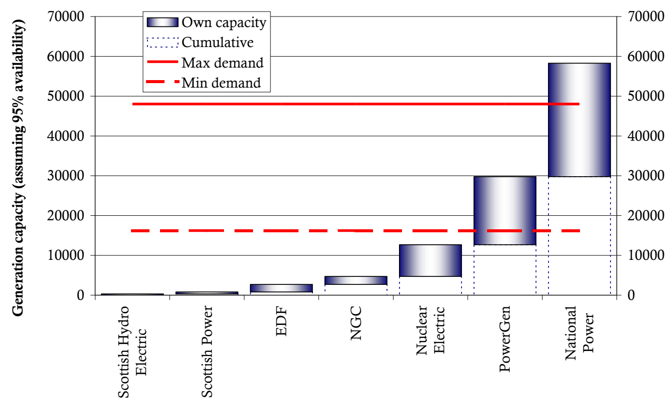
[36] Find Reference
[37] DRAX SEC 10-k
[38] The graph is from a presentation by Philip Burns of Frontier Economics in London, October 12, 2000. "The Implications of Regulation and Competition for Corporate Activity."

sustainable politically – implying the historic trends and volatility in prices did not provide much guidance for prospective prices.

After Reforms



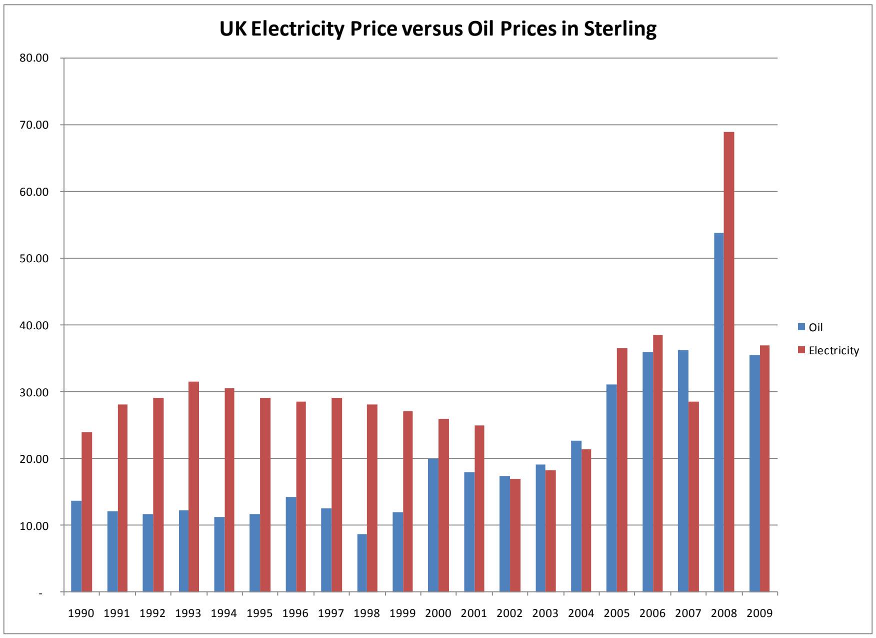
Before Reforms



Given the changed market structure and the increased capacity, statistical analysis of historic prices turned out to be irrelevant in valuation analysis. Furthermore, with a more atomized structure plants become price takers and prices can move all the way down to short-run marginal cost – the variable running cost of plants "on the margin." Changes in the structure of regulation and the over-capacity caused market clearing prices to change dramatically. Before the market reforms, the annual volatility in prices was small and the level of prices remained flat. However after the addition of capacity and the atomization of plant ownership, prices declined dramatically as shown on the graph below39. The graph demonstrates that for the first decade that the market operated, prices were essentially constant at £25/MWH40 while they declined to about £17/MWH in 2001. According to a 2003 US Energy Information Agency report: "[w]hile restructuring of the electricity industry was intended to end market abuses by large electricity generators and increase the market's efficiency, the system has been so successful that in the last four years, prices have decreased by about 40%."41 The graph demonstrates that the decline in prices was particularly dramatic when viewed in the context of primary energy prices.

[39] From Hugh Outhred, "Global trends in electricity markets", School of Electrical Engineering and Telecommunications The University of New South Wales Sydney, Australia

[40] Moody's report on Drax, 2000.
[41] www/eia.us.gov, 2003



Valuation Issue 2 – Appropriate Debt to Capital Ratios and Credit Analysis

In constructing the new capacity and applying high debt to capital ratios to the plants, investors, and more importantly banks, made an implicit or explicit assumption that stable prices would continue. This assumption depended on limited surplus capacity and continuation of the oligopolistic market structure. The value fell by more than the debt to capital implied amount and the plants had no second way out. With hindsight, it is clear that neither of the assumption of stable capacity relative to demand nor a continued oligopolistic market structure were sensible. Capacity was being added much faster than demand and slow demand growth in the U.K. meant that surplus capacity would last a long time as demonstrated by the table below. The increase in capacity was due to the fact that natural gas combined cycle facilities could operate profitability at pricing levels that historically existed in the market. The private power plants that were developed increased the U.K. reserve margin (the amount of capacity divided by the peak load) to more than 25%, far above the typical reserve margin criteria used in the industry of 15%.

UK Demand and Supply GW	
Natural Gas and Conventional	18.5
Nuclear	1.2
Total	19.7
Demand Growth	2.7

When banks evaluated the level of debt that was supportable, they used forward market prices studies performed by consultants who provided forecasted price levels and ranges over long-periods of 20 years or more. With hindsight these studies performed by firms with no financial interest in the pant did not predict actual declines in electricity price that occurred. The following statement made by the rating agency Moody's in reference to a study prepared by a consulting company named Camus for the AES transaction in 1999 illustrates the mistakes: "we do not expect … a sudden and marked fall in wholesale electricity prices in England and Wales." While many plant owners complained about the NETA market rules, the underlying reason for price declines and volatility were overcapacity and reduced market concentration. A financial report of AES Drax, the subject company discussed below, summarized this as follows: "Although NETA has impacted electricity prices, NETA has not generally been considered to be the principal underlying cause behind the decline in UK power prices; this is more likely due to the over-capacity in the UK generation market, increased competition and fragmentation of the market." 42 With the new market structure future price volatility and price trends could not have been predicted from historic volatility and price trends. The price declines caused by overcapacity were by no means limited to the U.K market. As stated above in the very first paragraph of this chapter, by one count, the merchant power industry lost $100 billion in market value in the early years of the 21st century. With hindsight, the changes in prices were predictable and the debt leverage was far too high for the plants.

While the financial situation of the plants have recovered, because of price declines in the years 2001-2004, many of the plants that were not supported by a contract were either bankrupt or in a state of serious financial distress. According to one commentator "less than ten years after the privatization of the electricity industry, the energy market has effectively gone bust."43 Banks had lent high levels of debt to the projects apparently without fully considering the potential for changes in the trends and volatility of prices – implying that the cost of capital was relatively low for these investments. The errors made in risk assessment implicitly

[42] AES 10-k Report for the year ended 12 December 2002, page 16.
[43] Britain's privatized energy industry on brink of bankruptcy By Jean Shaoul, 23 October 2002

resulted in incorrect cost of capital which in turn lead to over-investment and financial distress. Had lenders made better estimates of debt capacity through realistically assessing the volatility of power prices and the potential for over-supply rather than simply using historic projections, investors would have made more rational investment decisions. The actual price volatility from a changed market structure demonstrates that risk and cost of capital was much higher than the cost of capital implicit in the high debt financing that occurred. The changed structure of the market meant that historic data was almost useless in projecting future trends. The potential variation and trends in future prices should have explicitly recognized the surplus capacity as well as the movement away from oligopolistic pricing.

Valuation Issue 3 – Coming Up with Downside Case Scenarios

The AES Drax in Yorkshire was one of many plants that experienced financial problems and illustrates the valuation mistakes made by investors and credit analysts in the U.K. power industry. AES is a large holding company that owns plants around the world and it had decided to let a merchant plant in Wales named the Fifoots plant enter into receivership because of the low power prices. According to AES, the plant was "no longer possible to sell power above its marginal cost of generation."44 Drax, a 3,960 MW station commissioned in two parts in 1974 and 1986, is the largest coal plant in Europe. In mid 1999, the plant was purchased by AES from National Power (renamed Innogy) for £1,963 million (the plant sale was driven by the government ordered divestitures associated with reducing market concentration discussed above.) The purchase price converted to a cost of US$758/kW – higher than the cost of an efficient new combined cycle plants that were typically dispatched ahead of coal plants in the U.K. market because of their lower marginal cost. In financing the plant, AES injected £224 million of its own equity, resulting in a debt to capital ratio of about 90%. The debt consisted of bonds which initially carried an investment grade rating of Baa2 by Moody's. A summary of the capital structure is shown on the table below. The bank debt carried a credit spread of 165 basis points and had a tenor of 15 years.

[44] AES 10-k, page 17.

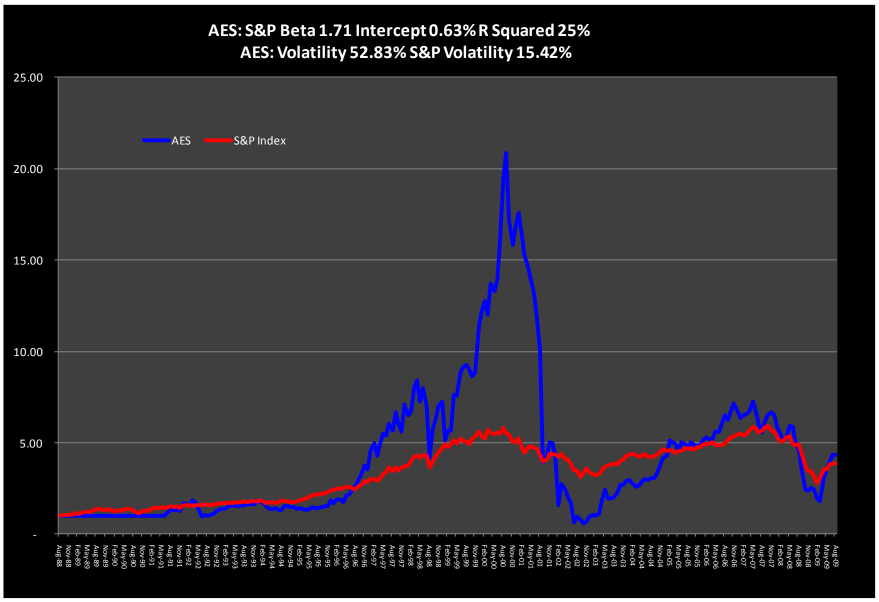
	GBP Millions	Percent
AES DRAX Holdings Limited Bonds	400.00	18.2%
AES DRAX Energy Senior Notes	267.00	12.1%
In Power Bank Facility	1,308.00	59.5%
Equity	224.00	10.2%
Total Capitalization	2,199.00	100.0%

Financial Projections

	Caminus Base Case	Caminus Low Case	Collapse Case (a)	50% Load Factor yr. 7	Reduced Plant Eff.	Reduced Availability
After Tax Operating Company ADSCR						
Average ADSCR (1-15)	1.72x	1.50x	1.48x	1.61x	1.66x	1.61x
Minimum ADSCR (1-15)	1.42x	1.27x	1.20x	1.35x	1.36x	1.19x
Average ADSCR (16-25)	5.11x	4.22x	4.15x	4.45x	4.96x	4.61x
Minimum ADSCR (16-25)	3.76x	3.09x	2.86x	3.29x	3.65x	3.40x
Average ADSCR (1-25)	3.05x	2.57x	2.32x	2.73x	2.96x	2.79x
Minimum ADSCR (1-25)	1.42x	1.27x	1.20x	1.35x	1.36x	1.19x
After Tax Holding Company ADSCR						
Average ADSCR (1-10)	3.09x	2.29x	1.89x	2.94x	2.81x	2.75x
Minimum ADSCR (1-10)	2.13x	1.48x	1.13x	2.01x	1.74x	1.00x
After Tax Consolidated ADSCR						
Average ADSCR (1-10)	1.33x	1.21x	1.15x	1.31x	1.29x	1.26x
Minimum ADSCR (1-10)	1.20x	1.08x	1.00x	1.14x	1.13x	1.00x
Average ADSCR (16-25)	4.82x	3.98x	3.93x	4.20x	4.68x	4.35x
Minimum ADSCR (16-25)	3.03x	2.53x	2.32x	2.70x	2.93x	2.74x
Average ADSCR (1-25)	2.74x	2.31x	2.09x	2.45x	2.66x	2.51x
Minimum ADSCR (1-25)	1.20x	1.08x	1.00x	1.14x	1.13x	1.00x
Moody's DTBE Analysis						
Merchant Revenue DTBE						
Year 1-15 Average	34.2%	26.2%	22.0%	32.8%	31.5%	29.8%
Year 15-25 Average "Merchant Period"	34.8%	30.5%	28.0%	33.4%	34.0%	32.5%
Year 1-25 Average	34.6%	28.0%	24.6%	33.2%	32.6%	30.9%

The bond rating of AES Drax was in part dependent on a contract the company signed with a company named TXU Europe for 50%-60% of the plant capacity for 15 years. One of the contract provisions mandated that AES Drax maintain an investment grade rating. Further, the financial status of TXU Europe depended on continued high market prices. After the price declines and a bond downgrade, TXU Europe terminated its contract in November 2002 and TXU Europe subsequently declared bankruptcy. This left AES Drax operating on a fully merchant basis. According to AES Drax financial reports, "The initial assumptions on which the AES Drax companies relied when making the original investment assumed that it would have the protection of its long-term Hedging Contract with TXU Europe and that electricity prices would remain at a certain level. Since we acquired the Drax Power Station electricity prices have declined on average by approximately 40% and in November 2002 our Hedging Contract with TXU Europe was terminated and the TXU group entered into administration." After not meeting debt service obligations, AES effectively

abandoned the plant in August 2003.[45] The table below illustrates the time line of AES Drax and the effects on the stock price of AES Corporation.



The case demonstrates that debt capacity does in fact affect investments – much more than the estimated cost equity of capital derived by someone making statistical analysis of beta in the CFO's office. Mistakes in valuation occur because trends and the volatility of operating cash flow is not gauged correctly by bankers. Here, the volatility of operating cash flow changed from historic levels and this change was not included in the analysis. The theory of using debt capacity in project finance to derive the cost of capital is discussed in Chapter 4. Practical and theoretical problems with the CAPM are first described. Then, use of debt capacity as a tool to objectively quantify is discussed.

AES DRAX Operating Data and Interest Payments				
	2000	**2001**	**2002**	**9 Mos 2003**
Operating Profit	174,523.00	143,404.00	115,843.00	(94,780.00)
Interest	153,325.00	166,011.00	175,444.00	137,670.00
Difference	21,198.00	(22,607.00)	(59,601.00)	(232,450.00)
Capacity Factor	66.48%	64.40%	56.30%	63.23%

The financial problems with DRAX were one of the reasons AES experienced a dramatic decline in its stock price as shown in the graph below.

[45] BBC Report

This case demonstrates that real investment decisions and cost of capital decisions do depend on debt capacity assessments made by banks. The mistakes in this case came from not realizing that prospective volatility in cash flows would be far higher than historic volatility. It is not suggested that a more accurate estimation of Beta and weighted average cost of capital could have solved anything, but rather that the credit analysis process is central to valuation.

While debt capacity analysis can be useful in valuation, it remains prone to mistakes because the level of risk and amount of debt may incorrectly assessed by lenders. If debt capacity can be used to measure overall risk of an investment, then mistakes made by lenders and credit rating agencies translate into poor investment decisions. One of the problems in using the risk assessment by lenders is that bankers, who are anxious to earn fees, convince themselves to believe forecasts that are not sensible. Further, risk assessment mistakes are compounded because after one major bank accepts the risk of a loan, if analysts at a second bank question the efficacy of the analysis, they are scoffed at. Suppose you are a credit analyst at a relatively small bank – ABC bank – and you believe there is too much risk for the suggested level of debt. A typical conversation may be that if Citibank and HSBC determined that a loan is an acceptable risk, who are you to say that you do a better analysis than such a very sophisticated bank. The case of project financed power plants in the United Kingdom illustrates how debt capacity in transactions can be used to quantify risk and how debt capacity assessment mistakes can lead to over-investment and incorrect valuation.

Chapter 3 and Chapter 4 attempt to address the issue – get around bankers by assessing risk through independent mathematical analysis. Use the good part of assessing volatility, but simulate the volatility instead of relying on the analysis of others. This gets around two problems, first the problem with cost of capital and beta and second, the problem of using bankers.

Chapter 8

Eurotunnel and Making Just About Every Project Finance Mistake

Conceptual Valuation Errors Made in the Case

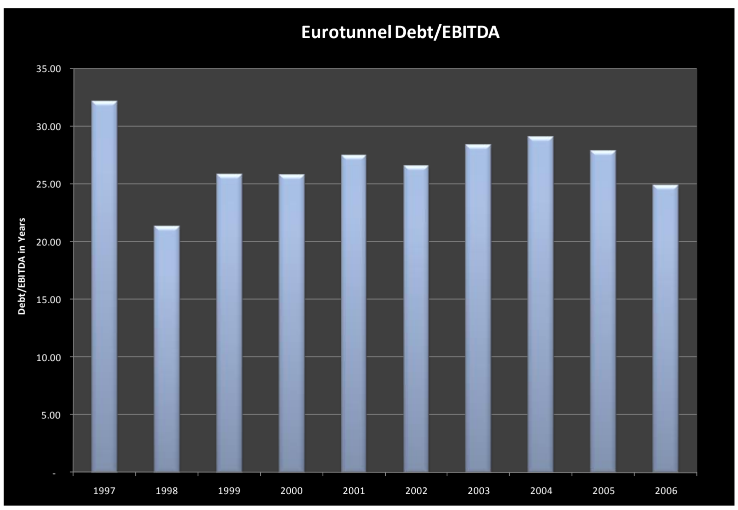
The Eurotunnel case must be one of the most used case studies in universities and workshops. The second case study addresses valuation errors from biases that can arise in key estimating economic drivers from variables in which no historic data exists. The situation discussed in the paragraphs below involves the mistakes that were made by bankers, investors and managers when constructing and financing the famous Eurotunnel Project between England and France. Many of the valuation mistakes arose from over-reliance on reports and opinions of experts rather than stepping back and evaluating simpler ways to consider the potential downside in assumptions related to construction cost and traffic revenues. Reviewing Eurotunnel prompts the question of how seemingly obvious assumptions (with hindsight, of course) could have been overlooked by highly sophisticated lenders, equity investors and project developers. The 31 mile (50 km) tunnel is the largest undersea tunnel in the world; it took seven years to construct (it was supposed to take five); the tunnel was originally expected to cost £4.5 billion when construction began in 1986 and its ultimate cost rose to about £10 billion.46 Traffic projections made by two of the most reputable firms that make traffic forecasts – Wilbur Smith and Associates and Setec – predicted revenues that turned out to be about three times actual levels in the initial year and even worse in subsequent years. Optimistic estimates of the construction cost, the timing of project completion, traffic volumes, and political support make the Eurotunnel project a poster child for what the U.K. calls optimism bias and the Standard and Poor's statement that: "[f]inancial projections …are probably

[46] There was a longer tunnel completed in Japan in 1988, but that tunnel was not as long under water as Eurotunnel. The tunnel in Japan took 17 years to construct compared to 8 years for Eurotunnel. Bonnanza, Partick, "Eurotunnel Le Hold-up Program", Editions Generals First, 1996, page 27.

inherently skewed toward successful results...hiding the true technical and operating risks inherent in many projects...”47

Synopsis of the Case

When it was completed in 1994 and to this day, Eurotunnel was the largest infrastructure project finance transaction ever completed. The project began with great fanfare regarding returns as well as the technical aspects of the project. Attempts to build a fixed line across the channel had been discussed for centuries and because of the political philosophy of the Thatcher Administration, Eurotunnel would be built “without a public penny,” being the opposite of a public-private partnership. Advertisements for buying stocks in Eurotunnel suggested investors could earn a rate of return (an IRR) of more than 18%. While Eurotunnel never officially went bankrupt, it has had severe financial problems from the time of its opening until it eliminated much of its debt in 2007. The financial distress of the project.



To demonstrate the meaning of Eurotunnel’s debt to EBITDA ratio of above 20 times, consider a simple analysis of how the ratio of Debt/EBITDA corresponds to debt service coverage. The table below shows this analysis by presenting debt service coverage at different levels of debt to EBITDA with

[47] Find Standard and Poor’s

different tenors of debt.[48] To read the table, look at the row with a debt tenor of 30 years. With this debt term, a debt to EBITDA ratio below than 10 times – less than one half of the Eurotunnel level -- is required to pay debt service. To put the Eurotunnel numbers in perspective, the ratio of debt to EBITDA reached levels as high as 7 times in aggressive leveraged buyout transactions at the height of the private equity boom. The table also shows that even if the debt tenor is extremely long (the concession period for Eurotunnel has been extended to 99 years), a debt to EBITDA level of above 12 times means debt service cannot ever be repaid. Eurotunnel's Debt/EBITDA ratios demonstrate there was no chance whatsoever that the project could repay its loans. (It also shows that debt to income ratios are far more relevant than debt to capital ratios as the debt to capital ratio for the project of about 80% was in line with other projects that had no problem paying off their debt.)

Ability to Pay Back Debt -- Debt Service Coverage -- with Different Terms at 7.00% Interest Rate

Term of Debt (Yrs)	Debt/EBITDA									
	2.0 x	**4.0 x**	**6.0 x**	**8.0 x**	**10.0 x**	**12.0 x**	**14.0 x**	**16.0 x**	**18.0 x**	**20.0 x**
50 Yrs	5.56	2.78	1.85	1.39	1.11	0.93	0.79	0.69	0.62	0.56
45 Yrs	5.42	2.71	1.81	1.36	1.08	0.90	0.77	0.68	0.60	0.54
40 Yrs	5.26	2.63	1.75	1.32	1.05	0.88	0.75	0.66	0.58	0.53
35 Yrs	5.07	2.54	1.69	1.27	1.01	0.85	0.72	0.63	0.56	0.51
30 Yrs	4.84	2.42	1.61	1.21	0.97	0.81	0.69	0.60	0.54	0.48
25 Yrs	4.55	2.27	1.52	1.14	0.91	0.76	0.65	0.57	0.51	0.45
20 Yrs	4.17	2.08	1.39	1.04	0.83	0.69	0.60	0.52	0.46	0.42
15 Yrs	3.66	1.83	1.22	0.91	0.73	0.61	0.52	0.46	0.41	0.37
10 Yrs	2.94	1.47	0.98	0.74	0.59	0.49	0.42	0.37	0.33	0.29
5 Yrs	1.85	0.93	0.62	0.46	0.37	0.31	0.26	0.23	0.21	0.19

The Eurotunnel project includes many classic valuation issues in addition to the focus of applying optimistic assumptions from consultant studies related to construction costs and traffic projections. These problems included distorted incentives because of the corporate structure, limited experience and reputation of equity investors, conflicts with the government and use of unconventional equipment:

First, a consortium of ten construction companies named TML that owned the majority of the shell company that was created for bidding on the concession. This shell company signed construction contracts even though TML eventually only owned a tiny fraction of investment, presenting a dramatic conflict

[48] Analysis underlying the numbers simplifies the real world because they does not include taxes that must be paid, working capital requirements associated with EBITDA or on-going capital expenditures that must be made to keep maintain EBITDA. If these additional items were included, the debt service coverage would be lower for each level of debt to EBITDA.

of interest. Problems with the construction contracts led to many construction over-runs and delays.

Second, the equity providers (mainly small French investors) did not have the wherewithal to evaluate the project economics provide assurance that somebody who gets paid after lenders could check the key valuation assumptions. With hindsight, partially because of weak sponsors, the managers of Eurotunnel neither negotiated effectively with bankers nor with TML nor did they seem to have the best interests of shareholders in mind.

Third, relationships between Eurotunnel and the governments of Britain and France were not aligned properly. Even though the project was directly related to the government activities – government owned railways operated the trains, the 55 year concession period was defined by the government, the project was awarded by the government, and the government defined the safety requirements, there was no direct or indirect financial support from the French or British governments.

Fourth, the complexity of the ventilation systems, the shuttles, the toll plazas, the electricity requirements and other items introduced risk that could not be gauged by evaluating the cost and performance of other projects.49

At the heart of any valuation problem including assessment of the credit quality of loans is an outlook for key economic assumptions. Investors must read consultant reports and understand the flaws and possible problems with assumptions. Perhaps the biggest mystery of the Eurotunnel story is why 225 different banks agreed to lend money to the project on the basis of a traffic forecast, a construction cost estimate and government support which with hindsight, were completely unreasonable. As construction and financing of the project progressed, lenders, Eurotunnel management and equity investors relied on the opinions of experts rather than using their own business judgment to question the basic logic of the assumptions. In his book on Eurotunnel, Patrick Bonazza summarized problems with relying on mathematical models and consultants: “Cette histoire montre a quel point il est dangereux de confire son destin a des model mathématiques.” (This story shows at what point it is dangerous to confide one’s destiny to mathematical models.)   He notes that Eurotunnel managers had a tendency to hide behind consultants who write complicated reports and who have no money invested in the project. Reliance on traffic consultants and engineering

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experts is similar to the way investors in CDO's hid behind rating agencies in the sub-prime crisis rather than considering the obvious possibility of a major decline in housing prices. We now know that rating agencies had distorted incentives as they were paid by investors (Moody's employees went on parachuting trips with clients); they did not have the staff to evaluate the volume of CDO's; their sophisticated mathematical models had bugs; and they had to develop ratings of $1 billion issues in a few hours.

Some assumptions in many valuations can be verified by physical observations and statistics such as variables related to the weather or geological analysis. Other assumptions can be evaluated by examining historical data such as reviewing price, demand and cost history. A third class of assumptions like the construction cost estimates for a unique facility and traffic projections for a new project are the most difficult to evaluate. For this type of assumption, where one cannot use technical analysis or past data, there is a tendency to use reports written by consultants and other experts. Relying on so-called experts means that one does not have to argue about things which are very difficult to predict such as when will a recession end, what the oil price will be in two years, or the construction cost and traffic projections for Eurotunnel. Many mistakes come from accepting studies without question and not applying simple back of the envelope models to check the conclusions of experts and from not applying enough downside variation to the consultant reports. Throwing multiple regressions, Monte Carlo simulation, complex economic models at a problem most of the time does not result in better valuations than stepping backing and using a simple model.

The optimism bias in constructing assumptions for Eurotunnel – and many other valuation nightmares – can be separated into different risk analysis stages and categories (see Chapter 3). To review Eurotunnel, optimism biases during two stages are considered. The first bias occurred during the construction when naïve estimates of cost and scheduling were made. Investigation of the second stage discusses why more careful evaluations of projected traffic were not developed by banks and equity investors. The construction cost estimates were developed by the construction contractor TML who in turn hired many consultants. As mentioned above, the traffic projections were developed by well-respected consulting firms.

Many aspects of the constructing Eurotunnel were unique and complex. Other than being the longest undersea tunnel, the toll plazas were the most sophisticated in the world; the rail shuttles required more safety equipment and

power than any others; the terminals in England and France resembled small airports; and the ventilation and cabling were more sophisticated than other projects. Despite all of these unique aspects of the project, the construction estimates were prepared rather quickly because of timing of the original proposal (about six months.) As with most projects, the cost estimates were made by detailed engineering analysis. Given a general tendency for complex projects to experience cost over-runs as well as scheduling delays, the idea that the project could experience problems should not have been a surprise. However, the contingencies for cost-overruns were not addressed well in financing and planning of the project. Construction contracts left Eurotunnel rather than TML paying for the increased costs. Agreements with the government of the United Kingdom and France were not flexible with respect to increased costs. Management of Eurotunnel did was not able to manage the relationship with TML to reduce costs of the project.

The construction over-runs and delays for the project were massive. A good way to summarize a project such as Eurotunnel during the construction phase is to examine where the money goes and where it comes from – a uses and sources statement. This analysis is shown below for the original construction estimate and the actual experience.50 Comparison of the two schedules shows that the primary cost over-runs were not in tunneling where tests had been made and the constructors had vast experience; they were instead in the fixed equipment including the rails, the cables, the shuttles, the toll equipment, the terminals and other equipment. The management of Eurotunnel went to war with the construction companies over the construction contracts, but it continued to insist on only buying premium equipment. For tunneling costs (representing roughly 50% of overall costs), TML was only responsible for 30% of cost overruns. Worse, TML's contribution to cost over-runs was capped at a maximum of 6% of the target cost. Eurotunnel had to pay 100% of any cost overruns over this cap. For non-tunneling costs, Eurotunnel agreed to pay all of the cost over-runs. Resolution of the disputes between Eurotunnel and TML generally favored TML. In the end, as shown in the two schedules below, the cost over-run was 117%.

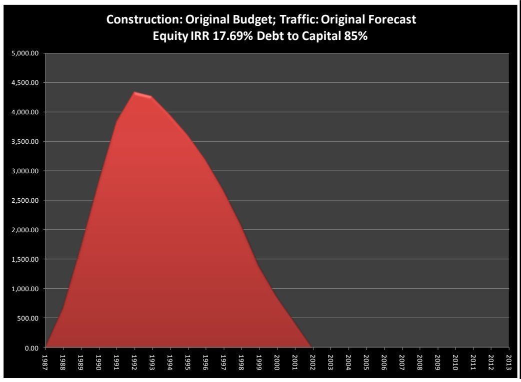
[50] The numbers are derived from historic Eurotunnel balance sheets and an estimate of cost increase components.

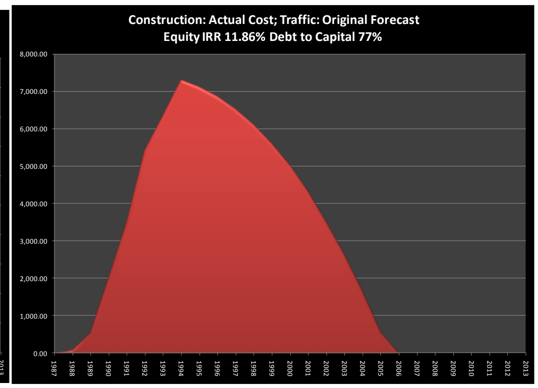
Eurotunnel Uses and Sources of Funds ₤ Millions - Original Estimate									
	1986	1987	1988	1989	1990	1991	1992	Total	Percent
Uses									
Capital Expenditures									
Tunnels	74	226	480	480	480	405	113	2,182	47.4%
Terminals	25	76	162	162	162	136	38	736	16.0%
Fixed Equipment	38	117	248	248	248	210	58	1,130	24.6%
Rolling Stock	14	42	88	88	88	75	21	402	8.7%
Total	**150**	**460**	**978**	**978**	**978**	**825**	**230**	**4,600**	**100.0%**
Sources									
Bank Loans									
Original Commitment (5 billion)			818	978	978	825	230	3,830	
Total Loans	-	-	818	978	978	825	230	3,830	83.3%
Equity Issue									
Founding Shareholders (TML)	46								
Institutional Investors	206								
First Public Floation (Nov 87)		770							
Total Equity Issuance	252	770	-	-	-	-	-	770	16.7%
Total	**252**	**770**	**818**	**978**	**978**	**825**	**230**	**4,600**	**100.0%**

Eurotunnel Uses and Sources of Funds ₤ Millions - Actual											
	1986	1987	1988	1989	1990	1991	1992	1993	1994	Total	Percent
Uses											
Capital Expenditures											
Tunnels	69	254	114	439	609	582	720	578	218	3,584	35.8%
Terminals	18	67	30	115	160	153	189	152	57	939	9.4%
Fixed Equipment	39	145	65	250	346	331	409	329	124	2,038	20.3%
Rolling Stock	23	85	38	147	203	195	240	193	73	1,198	11.9%
Total Direct Costs	150	551	247	951	1,318	1,261	1,558	1,252	471	7,759	77.4%
Other Uses											
Working Capital	102	221	(78)	(105)	403	(328)	(278)	(167)	483	253	2.5%
Deferred Expenses			-	-	-	-	11	146	151	308	3.1%
Capitalised Interest	-	0	7	47	128	218	321	444	537	1,702	17.0%
Total	**252**	**772**	**176**	**893**	**1,849**	**1,151**	**1,612**	**1,675**	**1,642**	**10,022**	**100.0%**
Sources											
Bank Loans											
Senior Loans									693	693	
Original Commitment (5 billion)		2	175	887	1,278	1,140	1,518			5,000	
Additional Commitment (1.8 billion)							86	1,672	102	1,860	
Total Loans	-	2	175	887	1,278	1,140	1,604	1,672	795	7,553	75.4%
Equity Issue											
Founding Shareholders (TML)	46										
Institutional Investors	206										
First Public Floation (Nov 87)		770									
Second Public Flotation (Nov 90)					566						
Third Public Floation (May 94)									816		
Total Equity Issuance	252	770	-	-	566	-	-	-	816	2,404	24.0%
Turnover		-	1	6	5	11	8	3	31	65	
Total	**252**	**772**	**176**	**893**	**1,849**	**1,151**	**1,612**	**1,675**	**1,642**	**10,022**	**100.0%**

Eurotunnel paid for the construction over-runs with a mixture of debt and equity. The original loan commitment which had a buffer of 25% was fully funded; an additional debt commitment was obtained and senior debt was issued in 1994. Further, additional issues of equity from selling shares were made in 1990 and 1994. The most controversial aspect of the financing was the issuance of the final equity of £816 million just before the project opened for traffic and a few months before it could not pay interest on its debt. This equity issue came from small investors (mostly in France) and projected rosy traffic projections. Notwithstanding all of the construction problems, the analysis below demonstrates that had the revenue forecast been realized, the project could have performed reasonably well from a financial perspective. The two graphs below show

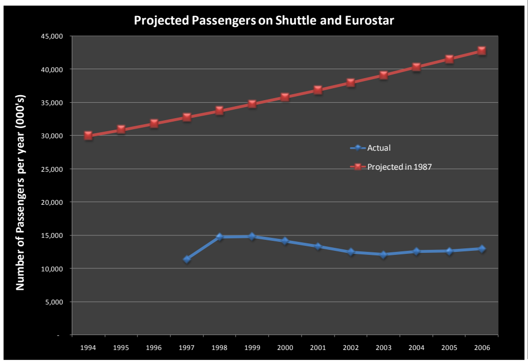
financial results of the project assuming no construction over-runs and with the actual over-runs and the scheduling delays. While the cost over-run caused the equity return to fall from 18% to 12%, the debt could still be repaid well before the 55 year concession as long as traffic projections made by Eurotunnel would have been realized.

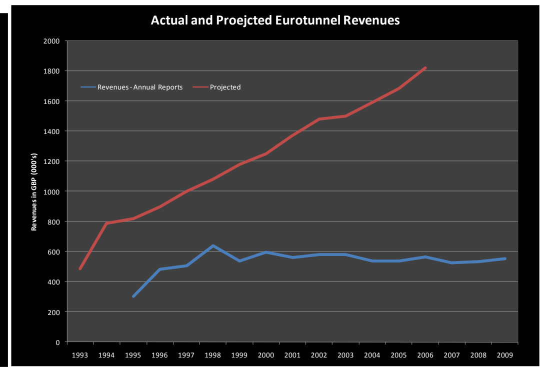




The second major assumption that turned out to be optimistic was the traffic estimates. Many infrastructure projects such as the Eurotunnel depend on a traffic study that projects the volume of sales that will be experienced. Airport revenues depend on the number of passengers; toll roads depend on the number of drivers; theme parks depend on the number of people who go through the turn-style, and the Eurotunnel depended on the amount of commercial and non-commercial traffic that would choose to pay travel between England and France in a tunnel underneath the channel. Traffic studies are essentially market share projections. The most difficult element is coming up with how much traffic will be diverted from other possible methods of traveling from one point to another. Unlike most other economic variables where analysis can be made of historic data, traffic projections must be made from a blank slate using surveys, assessment of how the speed limit will affect travel and econometric analysis of how much money people are willing to pay to reach their destination faster. The traffic studies used by Eurotunnel to arrange financing turned out to be three times more than the actual level of traffic realized and resulted in actual revenues that were a fraction of the projected revenues as shown in the table below. For example, in 1999, actual revenues of £654 million were only 56% of the £1,158 million projected in the original 1987 prospectus. For earlier years, the errors were even higher. According to David Freud of Warburg, the investment house which sold Eurotunnel shares to the public: "we were predicting that on Eurostar there would be 21 million passengers annually." The actual figure was less than a third of that.

Another analyst noted that "So the traffic forecasts were not just out by a little bit. They were completely potty; they were nowhere."51 The graphs below which compare actual passenger traffic and revenue projections to the 1987 forecasts show that the starting points of the traffic and revenue projections were completely wrong as were the growth rates.





Eurotunnel has by no means been the only project to underestimate traffic. Actual traffic levels have been dramatically different than traffic forecasts for many toll roads and for other projects such as Eurodisney. In 2002 JP Morgan completed a study of toll roads which complied the actual traffic relative to the projected traffic for a number of different toll roads in the U.S.52 The study demonstrated that for roads which were not built in areas with existing traffic congestion where it was hoped that the road itself would lead to increased business activity and traffic, the amount by which traffic was overestimated ranged from 10% to 80%.53 The graph below summarizes the JP Morgan analysis and demonstrates the clear tendency of the traffic studies to be dramatically over-optimistic. This study did not delve into the econometric equations used by the economists who performed the traffic study; it simply computed the actual versus forecasted levels. The natural question analysts should ask about prospective toll roads is why similar traffic errors will not occur.

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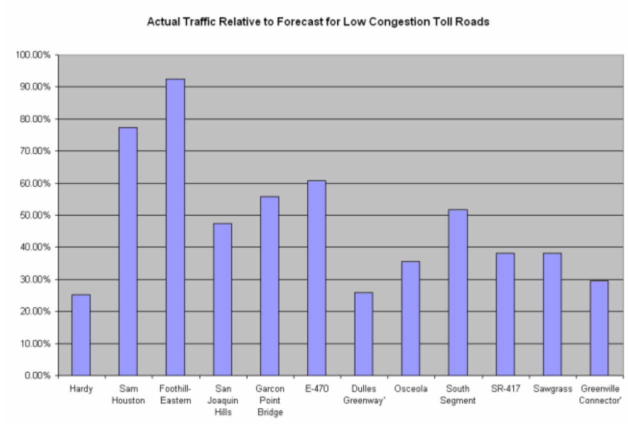
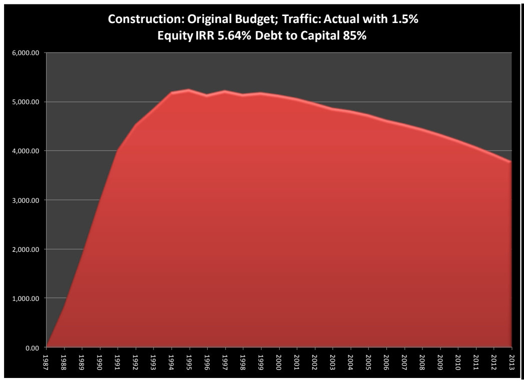
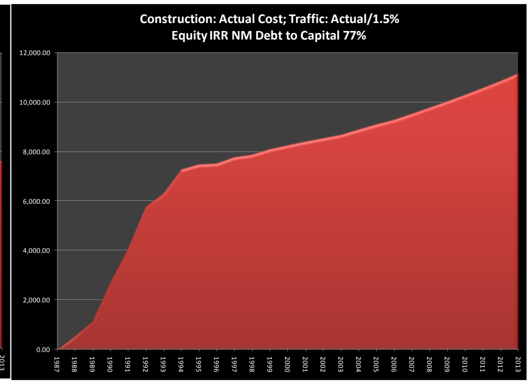
52 Muller, Robert, Separating Winners from Losers, Municipal Credit Monitor, May 10, 2002.

53 Find Reference to JP Morgan study



The traffic studies were reasonable with respect to the total amount of traffic that would cross the channel (mainly English traveling to France.) However the studies completely missed the market share that would be gained by the tunnel and lost by the Ferries. In addition, the traffic studies were wrong with respect to the growth in revenues. The number of passengers crossing the channel was expected to jump to 125 million in 2003 from 76.5 million in the 1990's. The traffic study consultants interviewed ferry companies and asked complex questions that they did not understand. Most importantly, the consultants did not recognize the potential for the bloody price war that occurred after the tunnel was built. The studies projected tolls per car of £64.5 in 1990. Actual realized tolls were only £34.4 in 1996. Given the surplus capacity that arose with completion of the tunnel (that included low cost airlines) prices moving down to short-run marginal cost should have been an expected result. The effects of the lower than expected revenues are shown in the two graphs below. The graph on the left shows the financial results for the project had the actual revenues been realized (with 1.5% growth after 2008), and the original construction budget been achieved, the project would have been eventually been able to pay off its debt and earn a small return on equity. However, in combination with the higher debt that was issued because of the construction cost over-runs, the debt could not be repaid, no matter how many attempts were made to extend the maturity of the debt or change other terms.





The notion of checking complex and often un-transparent valuation analyses with simple models does not mean that the thought process which goes into a simplified explanation is easy. Indeed, verification of valuations with back of the envelop analysis probably requires much more creativity and thinking about the valuation than entering multitudes of inputs into a sophisticated software model. This verification process which can involve anything from driving around inspecting the number of new homes around American suburbs to tabulating summary statistics from complex analysis is just as important as the multi-hundred page consultant report.

When analyzing a project such as Eurotunnel in which many other banks have already agreed to accept the risk, it is not easy for a junior credit analyst to question the complicated analyses that underlie the project such as a market study, a traffic analysis, a detailed synergy assessment, a set of regression equations or some other complex model. Not only have the analyses been constructed by experts who are supposedly independent, but the analyst would be questioning the judgment of many very smart financial analysts from large financial institutions. The temptation in such a case is not to take the personal risk of questioning so many others and to simply accept the complex analysis because there seems to be no other alternative. However, at minimum you can use the simpler data to develop break-even points and developing scenario analysis discussed in Chapter 3.

Chapter 6

Supposedly Innovative Valuation Techniques and the Case of Valuing Peaking Plants using Option Pricing Models

Conceptual Valuation Errors Made in the Case

Cannot assume that returns obviously above the cost of capital can be earned in an industry with open entry and similar costs

Cannot assume that can earn economic profits from real options because everybody else will come in and push the returns down

Mean reversion often limits the returns that can be earned from real options

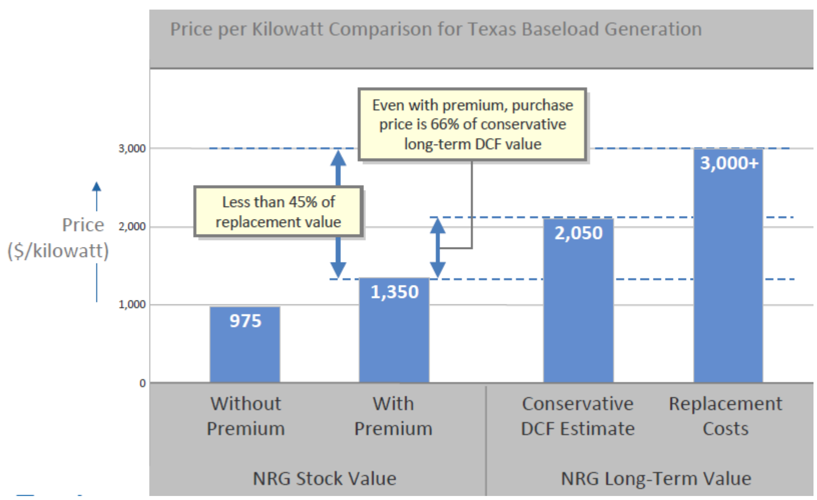
The third case addresses valuation mistakes that arise when new and supposedly innovative valuation techniques are accepted by financial analysts without having fully worked through the fundamental logic of the approaches and without rigorously testing whether the assumptions inherent in the new models make sense. The particular situation discussed below involves the application of real options analysis which was used in valuation of electricity peaking plants constructed in the late 1990's and early 2000's in lieu of more traditional discojnted cash flow techniques. (Peaking plants only operate during times of the year when electricity demand is very high and are a necessary component of most electricity systems because electricity cannot be stored.) Use of real options analysis and other non-traditional valuation techniques was fashionable in the mid to late 1990's for all sorts of investments and many of the non-traditional valuation ideas continue to be a popular today. When making decisions to invest in peaking plants, the real option models were often manipulated to imply that the value of a new or existing plant was higher than its replacement cost, even though

the industry was very competitive and there were minimal barriers to entry. This led sophisticated consultants and leading energy companies to argue that new investments could be very profitable even though many companies were in the business. While the analyses were elaborate, they ultimately went against some of the most fundamental ideas in valuation. The first concept that many of the analyses conflicted with is the notion that to create value, you must have some kind of competitive advantage which allows a firm to earn a rate of return higher than its cost of capital. Competitive advantage did not really exist because at the time, the market for capacity additions was very competitive and there were not many differences in technical features between the plants that were constructed by different companies. Second, application of option premiums to the value of peaking plants went against the basic idea that value comes from future cash flow along with the risk of that cash flow. The added cash flow that could be realized by the option was not observable and it was not easy to "show me the money" meaning that one could often not see how option premiums could result in actual cash flows. In particular, the option price models were misapplied because they assumed cash flows from an electricity plant result from a wandering random walk pattern rather than a process which bounces back to average levels (known as mean reversion.)

Synopsis of the Case

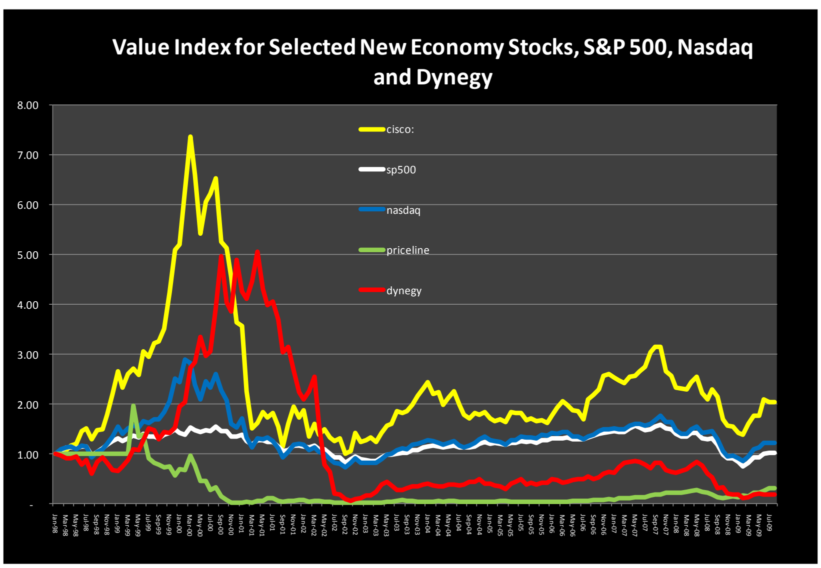
The idea of using option pricing models to value generating plants began at a similar time that deregulation of power generation was occurring in various regions of the U.S. in the mid 1990's. Deregulation resulted in many generating asset purchase and sales transactions for which values fluctuated dramatically. Most of the power plants involved in the transactions had been financed and constructed under a regulated system and, after being owned by one company for decades; they were bought and sold multiple times. A number of companies were anxious to enter the generation business including formerly regulated utility companies (who all somehow believed they had a competitive advantage in managing plants in other regions after they sold their own plants) and companies that had built independent power plants and trading companies such as Enron and Dynegy. One reason for large variations in asset prices was because some companies began to apply real options and other exotic non-traditional valuation approaches that differed from traditional discounted cash flow models. An example of the volatile plant valuations is two transactions for the purchase and sale of the same generating plants in Texas. These generating plants were first purchased by a private equity firm and then sold about two years later to NRG Energy. Even though the plants were identical, the value in the second transaction

was orders of magnitude above the price in the first transaction. In some cases, the sale prices for aging and relatively inefficient plants were above the estimated cost of efficient new combined cycle plants. At the time, new combined cycle plants were estimated to cost around $400/kW to $650/kW and their efficiency had improved dramatically over the past decade. In one case discussed in Chapter 2, FPL of Florida paid more than $700/kW – well more than replacement cost -- for relatively old steam fired oil and gas plants in New England. Debates about the appropriate method to use in valuation did not end after many companies went bankrupt by over-paying for generating plants. The chart below illustrates valuations from a proposed 2009 transaction where a wide range in values resulted from application of different valuation techniques. The first two bars on the chart show that the implied valuation of generating capacity in stock prices is much less than other valuation techniques, while the last two bars show that the valuation using discounted cash flow differs from replacement cost.



Real options models were introduced to value peaking plants in the late 1990's which was the same period when innovative valuation techniques were advocated for "new economy stocks." At the time, many people suggested that classic valuation analysis founded on discounted cash flow had become all but obsolete. Real options analysis was by no means the only non-traditional valuation technique that was applied. Other valuation approaches included attempts to measure how factors such as the number of customers, supply of shares, market sentiment, chart patterns and general market psychology affected the value of an investment. The general idea of using option models for dotcom companies could be summarized as follows. Major costs of a dotcom company were often a few employees who could be sent home if the company did not ultimately pan out. On the other hand, investors believed the company could

become immensely successful if the business plan was worked. Therefore, the cash flow payoffs from owning a dotcom company resembled a call option with limited downside and large upside potential. Given the cash flow patterns, factors such as the value per customer and growth in revenues drove stock prices of so-called new economy stocks rather than basic evaluation of whether the company could really produce economic profit. Because of the upside carrot and something called a "first-mover advantage", analysts would explain valuations of dotcom companies and other new economy stocks (which we now know were irrational) in very articulate terms using sophisticated financial concepts. For example, Alan Greenspan theorized that valuations of dot com companies could be explained by a "lottery effect" where investors were (rationally) looking for the next Microsoft and willing to take bets on many companies to find the good one. These new economy stocks included some energy companies such as Dynegy, Williams and Enron as well as technology and Telecommunications firms. Illustrations of selected stock prices for new economy stocks relative to the S&P 500 are shown below for companies that managed to survive the bubble without going bankrupt.



The problem with the idea that a large potential upside can be realized while the downside is limited is that some kind of real competitive advantage and barrier to entry must be present in order to ultimately realize high returns in the upside scenario. In fact, without some kind of monopoly power, large profits promised in the upside could never be realized. The problem is that if somebody else can hire a few employees and use the same business model, realizing returns

far above the cost of capital is not possible in a competitive economy. Koller et. all capture the general attitudes at the time:

"By the time the Internet frenzy peaked at the end of the 1990s, even staunch traditionalists like Warren Buffet pondered whether the economy had entered a new era of prosperity unbounded by traditional constraints. Some economists took to questioning long-held tenets of competitive advantage, and "new economy" analysts asked, with the utmost seriousness, why a three-year-old-money-losing Internet purveyor of pet supplies shouldn't be worth more than a billion dollars."54

When many electricity plants were built in the 1999-2001 period, the idea of using option price models to justifying high valuations was also used in the electricity generation industry, particularly with respect to peaking plants. The general notion was that a plant operates like an option because every single hour of the year that the plant operates, it has the option to switch off and not produce. (Chapter 5) The option not to dispatch a peaking plant meant that the downside case cash flow was limited, while more volatility in prices allowed the investment to take advantage of high prices. Intelligent and fast talking analysts taking a tour of an electricity power plant would refer to the facility as a "cloud of options" rather than a machine which uses natural gas to produce electricity. This idea that the right to dispatch could be a valuable option was explained as follows from two articles published in 1999:

Commodity traders have known for some time that practical examples of real options are available every day in commodity production and distribution. It is the implicit real optionality of production assets that makes the electricity markets unique. Many types of generation assets can be economically shut down (and later restarted) in a matter of hours or days in response to market signals. Because of their high degree of operational flexibility, an electricity generation asset probably is the most practical and realistic example of a real option."55

A generating facility is a "spread position" between the cost of fuel and the price of power, both of which are uncertain. What type of spread it is depends upon the operating characteristics of the plant. If the plant can be economically taken down and brought up in response to input and output price changes, it is

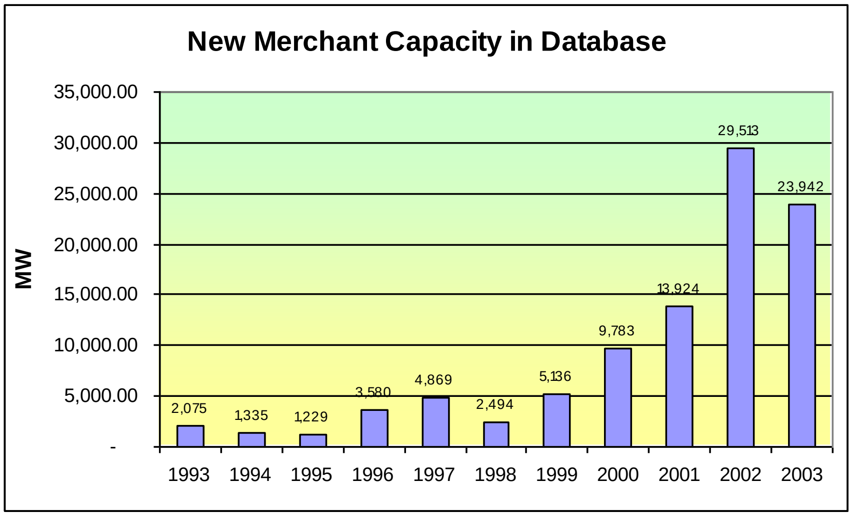
[54] Koller et. All.
[55] Derivatives Week, " ".

equivalent to an option on the spread between the fuel cost and the power price, with a strike price equal to the cost of turning the plant on or turning it off."

The use of real option models to value generating plants was boosted by extremely volatile prices that occurred in the summer of 1998 in the middle section of the U.S. Because of a combination of hot temperatures, nuclear plant outages, transmission limitations, and other factors, electricity prices increased from their normal levels of between $20/MWH and $40/MWH to $7,000/MHW in a single hour in that summer. The extremely high prices which had never been experienced before only lasted for a few days (and the $7,000/MWH price only lasted for an hour or two.) Despite the relatively short duration of the price spikes, they prompted many in the industry to make investments that could profit from similar spikes in the future. If prices of $7,000/MWH could be realized only for a couple of days, the revenues realized from these two days of high price could pay off the entire capital cost of a peaking plant that at the time cost about $400/kW. Traditional discounted cash flow models which used the expected value of data for hourly demand and the cost characteristics of generating plants in a region did not predict price spikes that could fluctuate anywhere near $7,000/MWH. Since peaking plants would capture the value of these price spikes without a high level of investment (limiting the downside), an alternative valuation approach analogous to the dotcom company methods seemed reasonable.

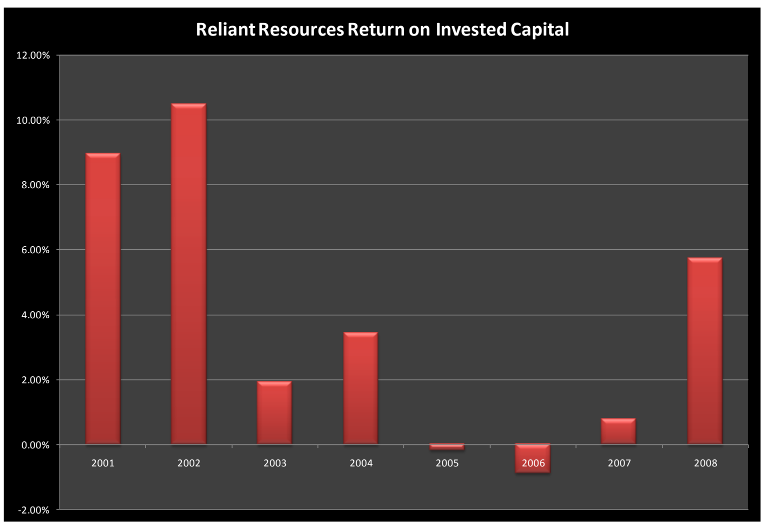
To compensate for problems that arise when one neglects the potential volatile distribution of prices, new peaking plants were often valued using option pricing techniques in the late 1990's. Energy companies and consultants would frequently follow a two step process when including the option value in analyses. The initial step was to compute value using traditional discounted cash flow models which measured the expected cash flows using most likely demand and supply assumptions in the market. The second step was an option increment to capture the value associated with potential price spikes and high volatility. The discounted cash flow component typically involved a supply and demand model that projected items such as electricity prices during peak periods as well as the expected utilization of the plant. This discounted cash flow part of the process was believed to undervalue the plants because it did not consider the option value from the right not to dispatch when prices are low and the opportunity to realize profits from prices which are very volatile. To account for the added option value, option price models using the Black-Scholes formula were added on top of the discounted cash flow value in the second part of the process. (Chapter 5) As mentioned above, the two step process often implied that the value that could be realized by from a new plant of plant was more than the cost of a new plant. Given that value could be realized from simply buying a peaking plant and

installing it somewhere on a transmission network, in many markets such as the Midwest of the U.S. (where the 1998 price spikes occurred) a number of peaking plants were constructed. The growth in merchant plants, many of which were peaking plants is illustrated on the graph below.



Technical details of applying real options to valuation of a peaking plant involved defining a peaking electricity plant as a series of call options. For each hour, when the price of electricity is above the variable cost, the plant should operate. (Chapter 5) On the other hand, for each hour when the price is below the variable cost, the plant can exercise its option not to run. The operating cost of a plant related to purchasing natural gas can also be defined as a series of call options. For each hour the plant operates, it is exercising an option to buy natural gas. If the price of natural gas (adjusted for production of electricity) is below the price of electricity, then the option is exercised. The cash produced from the peaking plant could therefore be replicated by buying a whole lot of call options on electricity for each hour of the plants operation (the options would realize the upside) and also selling a whole lot of call options on the price of natural gas (these options would make the option holder pay for natural gas when the plant operates.) If cash flows from the plant could be replicated through buying and selling options, then the value of the plant should be the same as the value of the options. The idea certainly sounded quite sophisticated and there is nothing wrong with the theory. The problem was finding the value of options over the entire lifetime of the plant and also entering reasonable assumptions into the option pricing models.

With hindsight, the option pricing analysis did not do a very good job in valuing the peaking plants as the plants did not generate anyway near the value that was predicted by the models. The price spikes of 1998 turned out to be a one time event as the constrained capacity did not happen again due in large part to the construction peaking capacity itself as well as improved performance of nuclear plants and other capacity. The real options models applied by companies such as Dynegy, Mirant, Reliant and NRG did not account for the reduced price volatility that occurred with increased capacity installations. Companies that constructed many plants including Mirant, and NRG Energy declared bankruptcy. Other companies including Calpine, Reliant and Dynegy had dramatic declines in their value and were almost bankrupt. The return on invested capital for Reliant Resources illustrated on the graph below shows how returns fell dramatically after the addition of merchant capacity in 2002 and hovered around zero for a few years. The returns only increased after special regulations were put in place by the government to support the income of peaking plants (this was called the reliability pricing model.)



Real options analysis was interesting to sophisticated analysts and it seemed to resolve valuation issues that could not well be included in traditional discounted cash flow models. However, the manner in which analysis was applied led to many bad investment decisions. Looking back, some of the mistakes in applying the real option approach included:

First, if the peaking plants were really more valuable than the cost of building a new plant because of the real options, then more plants would be built, increasing supply. As more plants are built because of their supposed value, the

increased supply would bring down prices. With lower prices, the value does is reduced and the optionality ultimately does not produce value. As with other investments made competitive markets, earning returns above the cost of capital is difficult.

Second, the options price models did not apply legitimate assumptions because the models did not correctly account for the very high mean reversion of electricity prices. (Chapter 3 and Chapter 5) Mean reversion dramatically reduces the value of options because the volatility that creates option value does not increase over time. In the case of electricity, volatility in supply and demand were already accounted for in supply and demand analysis, as all of the variation in weather and other factors that caused demand to fluctuate within a year were already accounted for as were potential outages in generating plants.

Third, the options models did not quantify the reduction in price volatility that occurs when industry capacity increases. As mentioned above, the peaking plants depended on extreme price spikes which in turn occurred from uncertain weather conditions combined with capacity constraints. When capacity additions increased, the nature of supply and demand changed which implied that the volatility dramatically declined as well as prices. (Chapter 6)

Fourth, the theoretical concepts involving arbitrage that were originally used to develop option valuation models conflicted with the idea that money over and above the investment cost could be made through investing in peaking plants. Option models were created by assuming that arbitrage strategies could be employed which means that if two alternate strategy produce the same cash flow, their value should be the same. Given that many companies could build plants to realize and create value from the option to dispatch, the value of the option could not be more than the value of the plant itself.

Fifth, if discounted cash flow models are created from hour by hour price analysis which include all of the variability in weather and plant performance over the year. If both volatility and 100% mean reversion were included in the price projections, the expected value of cash flow does not change because of an option. There are some hours with higher cash flow and some with lower cash flow, but the option to not dispatch does not have a major effect on value. (Chapter 5)

The case of building peaking plants around the turn of the century demonstrates that while it is easy to become infatuated by non-traditional

valuation techniques, realistic implementation of innovative models is more difficult to implement. When valuations deviate from the underlying present value of earnings and cash flow, financial experts tend to come up with explanations of why the current valuation is really correct and why old fashion valuation models do not work, rather than simply stating that asset prices are different than underlying value. They propound the idea that the world is really different this time and historic valuation techniques no longer apply. People who question the new techniques are scoffed at as being old fashioned and simply not having the brain power to understand innovative financial techniques. As we now know from the dotcom, merchant peaking plants and other experiences, most of the excessive valuations that were derived from non-traditional valuation techniques without paying attention to competitive advantage and cash flow were not sustainable. The danger is effectively explained by Kohler et. all:

"Those who questioned the new economics were handed as people who simply "didn't get it." The Internet bubble shows what happens when managers, investors, and bankers ignore the fundamental principles of economics and the underlying history of value creation…The Internet bubble years were full of intellectual shortcuts to justify absurd share prices for technology companies. The history of innovation has shown how difficult it is to earn monopolized sized rents except in very limited circumstances."

The general discussion of real option price models does not mean that this type of analysis has no place in valuation. Option price models have become an important tool for measuring the value of many financial and real assets and the ability to quantify the value of an option contract is clearly an important innovation in finance. One of the reasons that option pricing models are so attractive is because they are built from arbitrage pricing theory and such they do not require estimation of Beta, WACC or other risk parameters that are virtually impossible to measure. Since the time Black and Scholes developed their model to value the right but not the obligation to buy or sell an asset in 1975 it has been used in more and more applications. (Chapter 5) Unlike the standard DCF models that assume cash flow distributions are symmetrical, in option price models the probability of returns below the base case cash flow forecasts are not the same as the potential for upside returns. For example, option pricing models can value situations where cash flow distributions are skewed such as cash flow realized by lenders and they have been applied to value non-financial investments such as research and development. The problem is that option price models can also be used in confusing ways to justify high valuations.

The errors in valuing peaking companies demonstrate the importance of checking the reasonableness of rate of return assumptions in financial projections. To illustrate the importance of verifying assumptions, say you are given the task to evaluate the value of a newly constructed five star hotel and there are quite a few similar five star hotels in process of construction in the area because the region has become a popular tourist destination. It is likely that your valuation process for the hotel involve examination of occupancy rates from other hotels, estimation of daily room tariffs supported by the market conditions and construction of many other assumptions regarding additional items such as food and beverage and operating costs. If, after detailed studies are made for all of these items, the analysis suggests that the overall return – the project IRR – is 45%, far above the cost of capital, one must ask what competitive advantage exists for this hotel and why wouldn't other hotels come into the market thereby brining the room tariff down. Here, the simple check is to compute the rate of return on investment implied in the valuation analysis and to question models that have returns far above the cost of capital.

When an industry is relatively competitive meaning companies can easily enter and exit, the earned return on incremental investments should not be much higher than the minimum return required by investors. If the return assumption implicit in a valuation multiple and/or the return assumption in a financial projection is substantially above the level a competitive (or the WACC if possible to calculate), then some operating assumption is probably wrong. An example of this is the equity IRR projected in the figure below computed in a similar time frame as the telecom boom, where developers of a merchant electric plant assumed they could achieve a return of almost 24% while their cost of capital was 12%. To illustrate the effect of this assumption, by earning a 24% return over the long life of a plant, an investment of $100 would grow to over $1,000 in twelve years and $21,000 by the end of the life of the plant. By comparison an investment earning the 12% cost of capital would only produce $1,700 over the 25 year life. The obvious question is if the plant could really earn 24%, why don't other developers rush into the market with the same idea. The answer is that they did and the market prices crashed because of oversupply, just like the case of the telecom crash.

Project Economics

Partnership Return on Equity:	23.58%
Partnership NPV @ 12% (000's of $101):	$83,036
Minimum Debt Coverage Ratio:	1.60
Maximum Debt Coverage Ratio:	4.65
Average Debt Coverage Ratio:	2.98

Table 1

Energy Merchant Corporate Credit Ratings Collapse (2001-2004)

	January 2004		Nov 2003		May 2001	
	Rating	Outlook	Rating	Outlook	Rating	Outlook
AES	B+	Negative	B+	Negative	BB	Positive
Allegheny	B	Negative	B	Negative	A	Stable
Aquila	B	Negative	B	Negative	BBB	Stable
Calpine	B	Negative	B	Negative	BB+	Stable
Dynegy	B	Negative	B	Negative	BBB	Stable
EME	B	Negative	B	Watch Neg	BBB-	Stable
El Paso	B	Negative	B+	Negative	BBB+	Stable
Mirant	D	-	D	-	BBB-	Stable
NEGT	D	-	D	-	BBB	Stable
NRG	B+	Stable	D	-	BBB-	Stable
Reliant	B	Negative	B	Negative	BBB+	Stable
Williams	B+	Negative	B+	Negative	BBB+	Stable

Chapter 9

Obsolesce, Over-Capacity and Growth without Return, the Great Telecom Meltdown and Iridium

Conceptual Valuation Errors Made in the Case

Forecasts where there is no history

Limitations on capacity

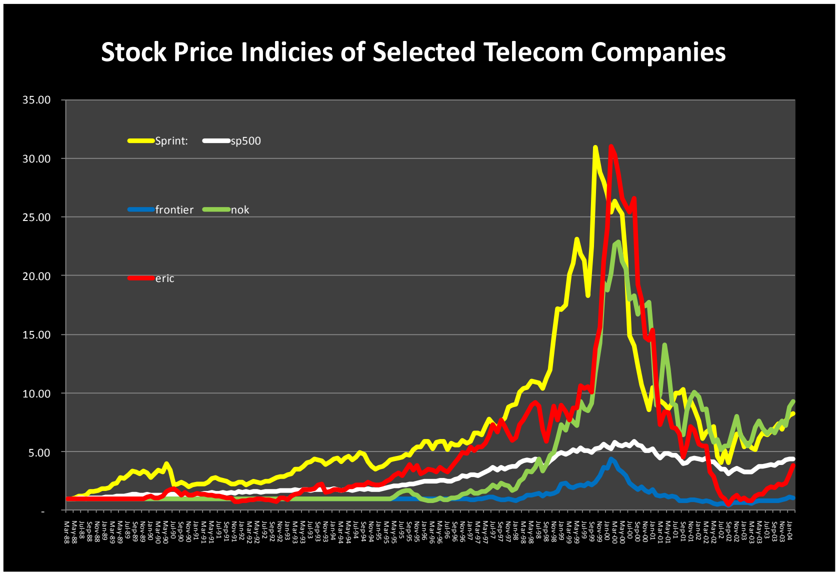
Relying on the reputation of sponsors and investment bankers

The fourth valuation case uses dramatic valuation mistakes in valuing telecom companies in the late 1990's and early 2000's that, with hindsight, ignored the fundamental sources of valuation – earning a return above the cost of capital and then growing the business. The telecom companies that were overvalued included firms that constructed fiber optic cable, marketed long-distance service, built satellites, and attempted to compete to offer local telephone service in the U.S. (Companies that provided local service and remained monopolistic did not experience the same kind of problems.) With hindsight, the very high telecom valuations resulted from making comical assumptions with respect to both growth revenues and the ability to earn a reasonable return on investment in the long-run. Values crashed after it became apparent that vigorous competition in some parts of the business along with over-supply caused prices, returns and growth prospects all to collapse. Overcapacity resulted from massive construction of telecommunications equipment that was intended to meet extremely high projected growth rates which did not come close to materializing. A dramatic case used to demonstrate these valuation mistakes is a company named Iridium that launched 66 satellites into space to provide service across the globe

and be a “first mover” in the industry. This company was created by Motorola and involved a $5 billion investment of which $3 billion was financed by debt. Iridium did not come anywhere near its targeted number of subscribers when it ran a major advertising campaign when operations began and it declared bankruptcy a year later, after which the assets were sold for only $25 million.

Synopsis of the Case

In the mid 1990’s, many telecom companies built fiber optic cable and other equipment to serve the backbone of the internet which was growing at an extremely fast pace. The growth in the telecom was eagerly financed by both equity and debt investors who bid-up the value of telecom companies to very high levels, as anything associated with the internet was considered desirable and investors were looking for companies that would have a first mover advantage that presumably could result in a sustained competitive advantage. In a similar manner as the case with sub-prime loans, when easy financing was available, more investment occurred (once again disproving the Modigliani and Miller thesis which suggests investment decisions should be independent of financing.) It is certainly true that the growth rate in capital expenditures and to a less extent in revenues for many companies was fairly high in the mid 1990’s because of growth in the internet and new telecommunication technologies. However there was no real prospect for the companies to earn anywhere near the return on capital invested required for the valuations as competition was very intense in many segments of the business and much of the industry was turning into a commodity business where prices are the driver of volumes. Eventually, investors realized that prospective return on capital would suffer because of competitiveness as well as the over-supply of capacity. With hindsight, initial assumptions behind the high valuations which implied that high returns could have been earned were never logical as there were few barriers to entry because it was easy for firms to enter the industry and finance massive capital expenditures. Values crashed as investors in debt and equity realized that genuine competitive advantage of any company that could lead to earning a return above the cost of capital did not exist meaning that the high price to earnings multiples which drove many valuations were not justified. The dramatic overvaluation and subsequent crash of the stock prices of selected telecommunications companies is illustrated on the graph below for selected companies.



We now know that many assumptions made by the most respected banks and investment banks on Wall Street were absurdly unrealistic for the industry. Some of these assumptions included:

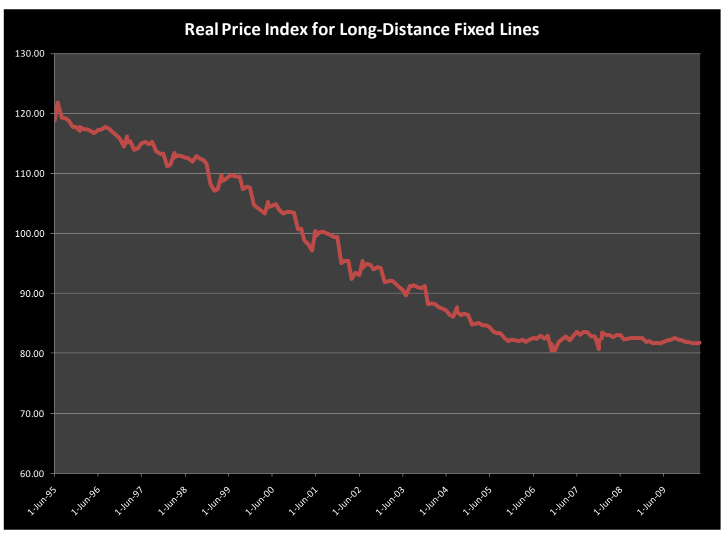
Very high assumed rates of growth for telecommunication equipment that was required to support growth in the internet that was not logical. As recounted below, prominent industry leaders asserted that the need for telecommunication equipment was growing at an incredible rate of 10 times per year. If even a much more modest rate of growth of 30% was experienced and telecom represented 2% of the overall economy, this growth rate would leave nothing else in the economy in a matter of six years. (Appendix 2 of Chapter 2 discusses growth assumptions in more detail).

Acceptance of valuation multiples -- P/E and EV/EBITDA ratios – that could not be justified unless both the earned return was far above the cost of capital and the growth rate was very high. The multiples were important because as equity analysts evaluating telecom companies could not justify the values of companies using discounted cash flow analysis, the valuations concentrated on comparative price to earnings (P/E) and EV/EBITDA multiples. For example the P/E ratio for Motorola, the major sponsor of Iridium, was ____ in ____ and the P/E ratio for in the MCI/Worldcom merger was ____. Using a model to derive the P/E ratio, one can derive the implicit assumptions on returns and growth that is required to justify different ratios (Appendix 1, Chapter 2.) For example, a P/E ratio of ____ could be justified if return above the cost of capital would continue to be about ___% for ____ years along with a rate of growth of ___% over the

short-term. These assumptions of returns above the cost of capital were inconsistent with the fact that despite a lot of advertising and discussion of how competition would produce innovation, long distance service had become a commodity with little potential for product differentiation.56

In a commodity business, the cost structure of an investment drives its profitability as products cannot be differentiated on the basis of prices. This simple principle was ignored by investment analysts who did not account for technology changes and the notion that marginal cost falls in a fixed cost industry as volumes increase.

Unrealistic beliefs that prices could be maintained in the face of massive surplus capacity. Between 1996 and 1999, almost one hundred and fifty marketing companies that buy space on networks and then sell telephone service to retail consumers entered the market. The existence of these marketing companies who operated on very thin profit margins limited the ability of larger companies that owned cable to increase prices. Competition was intensely price-based, and prices per minute fell dramatically as illustrated on the graph below.57



In some cases there was an implicit assumption that prices were relatively inelastic and that consumers would be willing to pay very high prices for services that were differentiated in minor ways from each other. Telecommunication

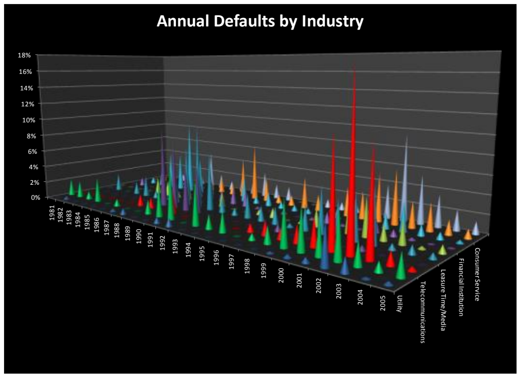
[56] Kamala Gollakota and Vipin Gupta, "Worldcom Inc.: What Went Wrong?", 2005, Ivey Management Services
[57] *"Telecom's Wake Up Call," Business Week, September 25, 2000.*

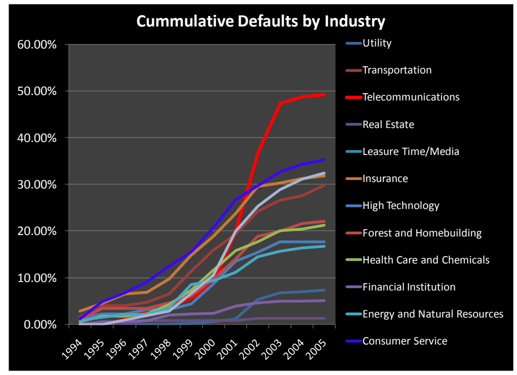
service was in reality a commodity service where competitive advantage came from either government regulation or a low cost structure.

Debt financing was not derived from realistic downside scenarios. As will be demonstrated by the Iridium case below, loans were made on the basis of business plans with no history and depended upon implausible assumptions with respect to both price and quantity sold. Given that the debt capacity of a project depends on being re-paid in a downside case scenario, it is now clear that the downside case assumptions were not at all prudent and that the probability of default on the loans was dramatically underestimated.

The crash in valuation of telecommunications companies demonstrates what happens when managers, consultants, investors, and bankers ignore the basic principles of how value is created and instead believe each other's stories. As in other cases, investors followed a flock instead of making independent analyses. When the market collapsed in 2001 and 2002, the fall in market values of both debt and equity was dramatic. According to one estimate, the decline in market value of debt and equity for companies in the telecom industry exceeded two trillion U.S. dollars.58 In 2001, seventy seven companies declared bankruptcy including Worldcom, which up until the fall of AA rated Lehman Brothers was the largest bankruptcy in U.S. history. Other noteworthy telecom bankruptcies included Global Crossing, the fourth largest bankruptcy in U.S. history along with Williams Telecom and Network Plus.59 The two graphs below illustrate the volume of defaults in the telecom industry as compared to some other industries; the cumulative default rate from 1994 to 2005 was more than 50% and far exceeded the defaults of other industries even at a time when overall defaults reached historic highs.60

[58] Goldstein, Fred, "The Great Telecom Meltdown, Artech House, 2005, Norwood MA.
[59] Freeman, Richard, "Meltdown of the Telecoms Continues, and Threatens World Financial System", April 12, 2002, Executive Intelligence Review.
[60] Standard and Poors.





One of the bases for the high valuations for telecom firms was the assumption that the demand would dramatically increase and allow prices for products supplied by telecom companies such as bandwidth to remain relatively high. Valuations implicit the P/E ratios and the EV/EBITDA multiples before the crash made the explicit or implicit unrealistic assumption that the telecom sector would expand perpetually by 15 to 30% per annum. The kind of thinking behind the demand forecasts during the boom period is recounted as follows in "The Great Telecom Meltdown:"

During the boom many people believed that Internet traffic was doubling roughly every 100 days. This fantasy was based on statements made by WorldCom in the 1997 time frame….It led to financiers to put up trillions of dollars in capital. After all, demand would soon catch up with whatever supply that could be built.

The specific reference to this growth rate was a statement of the chief financial officer of Worldcom, John Sidgemore, who stated61:

We're seeing growth at an unprecedented level. Our backbone doubles every 3.7 months, which means that it's growing by a factor of 10 every year. So three

years from now, we expect our network to be 1,000 times the size it is today. . . . The big challenge is to deploy infrastructure fast enough to accommodate such a growth rate. We're in a supply-constrained economy for the first time in the telecom industry.

[61] Crowe, Thomas, "The Telecom Meltdown…Looking For The Underlying Reasons"

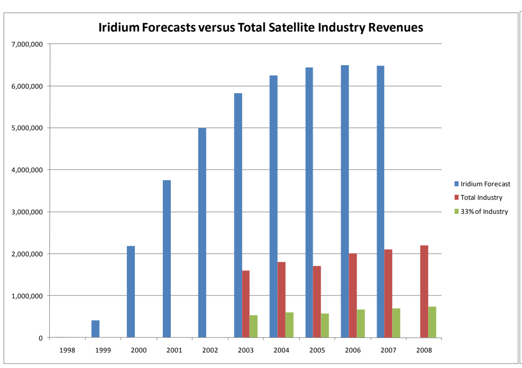
Mistakes in valuing telecom companies were a cousin of valuation errors in the dotcom bubble where companies that were associated with the internet achieved valuations that are nonsensical with hindsight. Because of the internet traffic that began to increase at a high rate in the 1990's, the telecommunications industry began to carry more traffic related to data than to voice calls around 1996.62 In the U.S., telecommunications networks built by AT&T, Sprint and MCI were running low on capacity and before 1995, prices for bandwidth to carry voice and data increased. In the late 1990's when access to capital was very easy -- driven by high valuations -- massive capacity expansion of fiber optic cable between cities occurred in the U.S. and elsewhere around the world (a company named Global Crossing placed large amounts of fiber underneath the Ocean.) During the boom period, companies installed fiber optic cable along railway lines, gas pipelines, roads and in other places. It seemed that to achieve a high valuation, companies could simply announce that they were in the process of building a national or super-regional fiber-optic network. Sometimes four to six companies built fiber-optic cable networks between or within the same major cities, which turned out to be orders of magnitude beyond prospective levels of voice or data transmission.

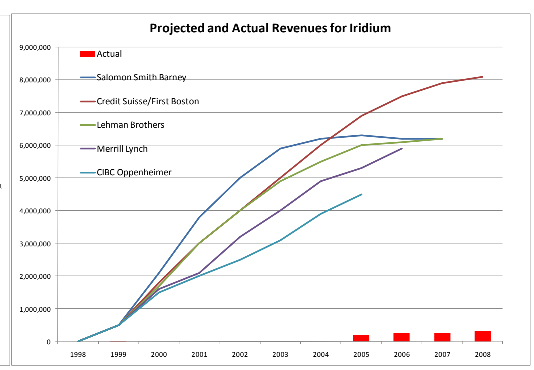
Unlike other industries, the amount of capacity and demand for bandwidth is not published and is not readily available (it is not in the economic interests of companies in the business to show the extent of the overcapacity.) However various sources have cited the immense amount of overcapacity in the industry. One study reported that 39 million miles of cable were laid underneath railroad beds, natural gas lines, corn fields, and roads—enough to encircle the Earth more than 1,500 times.63 Another analyst reported that over the four years between 1998 and 2001, the amount of fiber in the ground increased five-fold. The five-fold increase, which is a lot, does not account for the technological advances in the capacity of fiber increased the transmission capacity of fiber by 100 times relative to the copper wire that had been previously used in the industry. This means that the true transmission capacity increased by a whopping factor of 500, nowhere close to the increase in demand driven by the internet.64 Yet another source suggested that there was an overbuilding of fiber-optic cable systems by a factor of at least ten times, meaning that most of the fiber cable that was laid in the ground is not even used. (Fiber optic cable requires computerized technology to make it work; until this is installed, the fiber optic is known as dark cable. As of

[62] Goldstein, Fred, "The Great Telecom Meltdown, Artech House, 2005, Norwood MA.
[63] Crowe, Thomas, "The Telecom Meltdown…Looking For The Underlying Reasons"
[64]"Too Many Debts, Too Few Calls," The Economist, July 18, 2002.

2006, less than 5% of the cable was "lit"; the rest remains dark, and most is not likely to be "lit," implying massive excess capacity.)

Examining the specific case of the Iridium satellite venture illustrates the type of errors made by financial analysts at the time. This company's $5 billion investment was predicated on the assumption that more than six million people would pay fees that exceeded $330 per hour to use the service. To arrive at the revenue assumptions made by prominent investment banks -- illustrated on the left hand side graph below -- one would have to assume that 30% of international business travelers would carry around an extra brief case with a large bulky phone that was very difficult to use and unreliable inside of an office building or a hotel. Prices charged by Iridium were to be lower than the current international rates; but there was no evidence that business travelers were already paying the high existing landline rates and this market could be diverted. As it turns out, virtually no business travelers used the Iridium phones and the revenue projections were nowhere close to amounts projected by Iridium's consultants and investment banks. The graph on the right displays the forecast made by Salomon Brothers, Iridium's financial advisor, to the total actual revenues received by all satellite companies and 33% of the total industry revenues (representing the expected Iridium market share.) The left hand side graph demonstrates the manner in which a number of investment banks acted like lemmings in making similar analyses and ignoring the most basic economic principles of price elasticity of demand. The graph on the right illustrates that problems in estimating revenues were not related to specific marketing problems at Iridium involving the availability of phones and the difficulty in using phones, but rather the subscribers for the entire industry were overestimated.





Perhaps the most intriguing question in the Iridium case is not the equity investment, but how could banks and other lenders provide more than $2.2 billion

of debt to the venture (the balance between the $2.2 billion and the $3 billion of debt discussed above is $800 million of debt guaranteed by Motorola and $240 million of subordinated debt provided by equity sponsors.) The timing and amount of debt capital raised by Iridium is illustrated on the sources and uses statement below. Decisions to make loans to the venture were surprising because there was no historical basis upon which a banker could verify the projections that were; there were no comparable projects that could be used to verify the project; and there were no contracts that guaranteed any revenue. Instead, according to the Iridium prospectus, estimated revenues derived from "interviewing more than 23,300 people." If lenders had simply seen the size of the phones and understood the complexities in using the phones (information that was publically available in the prospectus), they surely would have been very skeptical of the projections and demanded much more than credit spreads ranging between 2.75% and 9.5% (the interest rate on treasury bills was about 4.5% and interest rates on the bonds ranged from 10.88% to 14%).

	Total	1991	1992	1993	1994	1995	1996	1997	1998	1999
Uses of Funds										
Payments Under Space System Contract	3,380,000,000	98,500,000	98,500,000	197,000,000	197,000,000	802,000,000	836,000,000	577,000,000	574,000,000	-
Payments Under Terrestial Contract	238,000,000	-	-	-	-	-	-	64,000,000	174,000,000	-
Other Construction Expenditures	409,002,000	18,312,750	18,312,750	18,312,750	18,312,750	26,178,000	164,415,000	145,158,000	-	-
Pre-Operating Expenses	749,162,000	5,483,000	5,483,000	10,966,000	16,729,000	26,436,000	70,730,000	177,474,000	435,861,000	-
Interest Paid	362,552,300	-	-	-	-	-	18,937,500	113,170,000	230,444,800	-
Total Uses of Funds	5,138,716,300	122,295,750	122,295,750	226,278,750	232,041,750	854,614,000	1,090,082,500	1,076,802,000	1,414,305,800	-
Sources of Funds										
Equity Financing	2,140,000,000	200,000,000	200,000,000	200,000,000	200,000,000	800,000,000	315,000,000	-	225,000,000	-
Guaranteed Bank Facility	745,000,000	-	-	-	-	-	505,000,000	(230,000,000)	350,000,000	120,000,000
Senior Bank Facility (Spread of 2.5%)	800,000,000	-	-	-	-	-	-	300,000,000	200,000,000	300,000,000
Senior Notes - A (Yield of 13%)	278,000,000							278,000,000		
Senior Notes - B (Yield of 14%)	480,000,000							480,000,000		
Senior Notes - C (Yield of 11.25%)	300,000,000							300,000,000		
Senior Notes - D (Yield of 10.88%)	342,000,000								342,000,000	
Subordinated Notes (Yield of 14.5%)	238,453,000	-	-	-	-	-	238,453,000	-	-	-
Interest on Cash Balance	1,027,260,859	-	2,331,128	4,732,189	4,085,792	3,247,113	1,706,107	808,405	3,405,868	-
Total	5,343,769,601	200,000,000	202,331,128	204,732,189	204,085,792	803,247,113	1,060,159,107	1,128,808,405	1,120,405,868	420,000,000
Percent Equity	40%									
Percent Guaranteed Debt	14%									
Percent Senior Debt	41%									
Percent Subordinated Debt	4%									

The high level of the credit spread may make one think that even if the project ultimately defaults, the high earnings from the credit spread in time period over which it did not yet default could make the high yield bond a good investment even if the bond ultimately did not pay its principal. For example, in an extreme case where the credit spread is 100%, the bondholders would have done better than the bondholders in government debt as long as the bankruptcy does not occur in the very first year. However if the loan defaults in the very first year and the recovery is zero (the loss given default is 100%) then bondholders lose everything. The required default rates to make a loan with a credit spread of 9.5% -- the highest credit spread for senior Iridium debt -- produce a profit relative to the risk free rate are shown on the table below. The first column of the table shows the rate of return realized by bondholders if the loans default in various periods; for example, if the loan defaults in the first year, the realized return is -91%. The second column shows the percent of default that could be acceptable if the loan were to realize the same expected return as a risk free bond. For example,

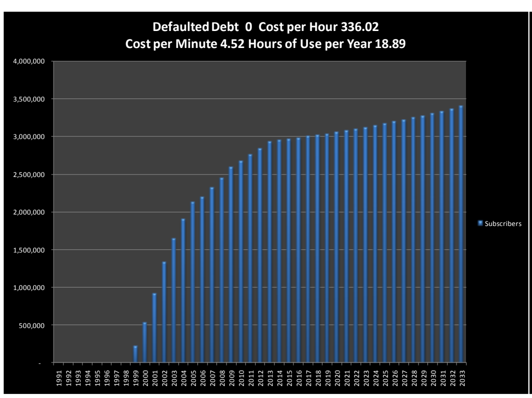
if there was a 9% chance that the loan would default in the first year, then the negative return of 91% would be acceptable if there was only a 9% that the loan would default. As the loan is outstanding for longer periods, the acceptable default increases because of earnings received on the bond.

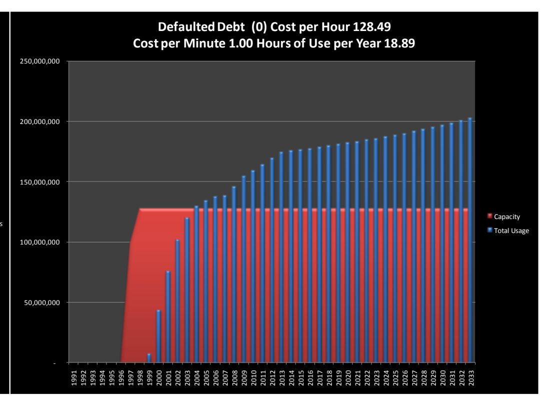
Default Year Assuming 100% Loss Given Default	IRR Earned on Debt Assuming Default in Various Years	Acceptable Default Probability to Be Equivalnet to Risk Free Rate	Expected Value from Default	Probability of Non Default	Expected Value from Non Default which is credit spread	Total Expected Value on Bond: IRR on Debt x Pd + Credit Spread x (1-pd)
1	-91.00%	9%	-8.40%	91%	9.25%	0%
2	-65.16%	12%	-8.10%	88%	9.25%	0%
3	-44.95%	17%	-7.67%	83%	9.25%	0%
4	-31.22%	23%	-7.14%	77%	9.25%	0%
5	-21.83%	30%	-6.50%	70%	9.25%	0%
6	-15.20%	38%	-5.75%	62%	9.25%	0%
7	-10.38%	47%	-4.89%	53%	9.25%	0%
8	-6.77%	58%	-3.91%	42%	9.25%	0%
9	-4.02%	70%	-2.80%	30%	9.25%	0%
10	-1.87%	83%	-1.56%	17%	9.25%	0%
11	-0.17%	98%	-0.16%	2%	9.25%	0%

Note: If IRR is zero, then the return earned on the bond is equivalent to a risk free bond
The Acceptable Default Rate is -credit spread/(IRR-Credit Spread)

The problem with Iridium from the standpoint of lenders is that either the technology would work from an economic perspective or it would be a flop; there was no in-between. Further, if it did not work, the failure would be quick. This is because the limited capacity of the satellites combined with the manufacturing cost of the phones meant that there was no flexibility to reduce prices. If business travelers would not adopt the satellite system, there was no “Plan B” that could be employed that would avoid a default and find enough cash flow to service the debt from other sources. Using the above table, this means that even if the company could struggle and stay in business for a couple of years, the only way the bonds could be profitable would be if with an 80% chance that chance that the business plan would really work. For the loans with a lower credit spread, the chances would have to be about 90% (the relationship between the probability of default and the credit spread is discussed in Chapter 4.) Analysis of the cost structure presented below demonstrates that the Iridium technology was not only highly exposed to obsolesce in the future, but that the technology was already obsolete at the time the loans were made. Making bets that a new technology with a high cost structure will have an 80% to 90% chance of success in a rapidly changing industry with a very high cost structure is an absurd bet for lenders.

Case studies written on Iridium typically describe the failure in terms of marketing problems. The company got the pricing completely wrong; it did not package the phones correctly – they were too large and bulky; and it did not manage the distribution channels correctly as it could not follow-up on a major advertising campaign. To test just whether alternative marketing strategies could have solved Iridium's problems, a financial model could be used. If the company would have reduced the price in attempting to increase usage, the financial model shows that capacity constraints made this unfeasible. This means the most essential point was not really marketing, but that the underlying cost and capacity constraints made the project uncompetitive with other technologies. A break-even analysis demonstrates that if all of the rest of Iridium's very optimistic assumptions with regard to price and usage could have been realized, the company would have still required about 3 million subscribers to repay its debt and provide lenders with their full return as shown in the left-hand side graph below. (Chapter 3) This amount of subscribers is more than the total subscribers that were actually achieved in the entire industry. Finding 3 million subscribers to lug around phones so they can pay rates of $330 per hour and not even use phones in buildings should have raised a lot of questions and put the business plan in doubt. If the price were reduced from $4.6 per minute to $1 per minute, (still a very high price compared to using cell phones for many international calls), then Iridium would have needed about 14 million subscribers to break-even as shown by the red graph on the right-hand side graph. However, with this many subscribers, the capacity of the system would be far exceeded as illustrated by the straight line on the graph. If the cost was further reduced to be to be any near realistic levels such as $.25 per minute or less, then the usage would have to far exceed the capacity. Finally, had Iridium borne the up-front cost of phones as a marketing strategy or had it spent more on making the phones smaller and sleeker, then the company's financial condition would have been even worse.





It may seem that in assessing the prospects for repaying debt that developing a financial model of Iridium would be all but useless. Attempting to carry around the bulky phones and understanding that they are very difficult to operate inside buildings should have been enough to refuse to lend any money to the project. However, collecting the data required to build a model and then understating how the model can perform break-even analysis as well as simple sensitivities does illuminate just how remarkable it was that the company obtained so much debt financing. When one computes a simple statistic involving how much the phone service costs retail consumers on an hourly basis – more than $330 per hour – one should have become very skeptical of whether 30% of business travelers would really use the service. Somebody would have to consider oneself very important to spend much time on the phone when it costs this much.

The underlying logic of Iridium was similar to the valuation process for many telecom company valuations being derived from a high growth rate in which market penetration and market share were often assumed to increase thereby justifying high valuation multiples – P/E ratios and EV/EBITDA ratios. The valuations were flawed not only because of the unrealistic demand growth assumptions but more importantly because of the implicit assumption that eventually, Iridium could earn a return above the cost of capital even though it did not have a viable cost structure and was obsolete before it was built. In the case of Iridium, the assumptions depended on realizing prices that could not be achieved in the face of competing technologies. When telecom investments obtained very high values, investors seemed to believe that merely building capacity in order to grow faster than your competitors would result in enormous value, even though there was no clear competitive distinction that would allow a company to earn a return above its cost of capital. For example, in the case of mobile-phone companies, growth in revenues and market share meant competing largely on price which in turn kept returns relatively low. For providers of fiber optic cable, even if growth could have been achieved, high returns would be extremely difficult to achieve because of the commodity nature of the business. The users of data, for the most part corporations, were paying lower prices for the data in bulk instead of paying on the more expensive per-minute basis.

Case 7 - Understanding Uncertainty in Demand Growth, Signing Contracts in the Philippines

Summary of Conceptual Valuation Errors Made in the Case

The seventh case considers valuation mistakes from not properly accounting for the flexibility of cost structure of companies in the face of unpredictable demand. The specific case involves uncertain demand forecasts in the Philippinnes which were very costly to businesses and people in the country because of a strategy that fixed the cost of power. When projecting cash flows, there is invariably some kind growth rate prediction that must be made, whether it is the growth in revenues, demand, prices, cash flow, earnings or productivity.

As introduced above, valuation boils down to forecasting future cash flows and then assigning risk to those case flows. As should be apparent already, the problem with valuation analysis is that both of these things are so difficult to measure.

Valuation errors addressed here involve mistakes in prediction of growth when valuing investments -- specifically not being humble about how difficult it is to predict growth rates in demand. The conclusion from reviewing case studies of growth rate prediction is that instead of believing that growth can be accurately forecast, valuation analysis should explicitly consider the risks of overestimating or underestimating growth. The cases demonstrates how a risk analysis process that may include sensitivity analysis, break-even analysis, scenario analysis and

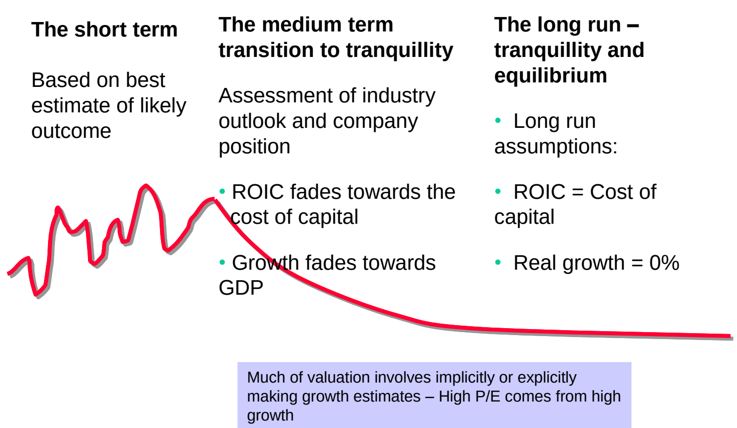
tornado diagrams is more reasonable than attempting to incorporate risk in the cost of capital.

Three prominent examples of growth rates that are central to measuring value include terminal growth rates estimated in standard discounted cash flow analyses ("DCF"); earnings per share growth rate forecasts made by equity analysts; and forecasted long-term demand growth rates in project finance analysis. In a standard discounted cash flow model, consultants, investment bankers and analysts typically create valuation models of corporations through projecting un-leveraged free cash flows over a five to ten year time frame and then applying a growth rate equal to or slightly above the rate of inflation to the cash flow forecasted in the final explicit year of the forecast. This growth rate in cash flows applied to cash flow in the terminal year along with the cash flow level at and the date at which the terminal year occurs are invariably two of the most important variables that drive the valuations, but often little thought goes into the analysis. The second example involving valuation models developed by equity analysts, often depends on projection of earnings growth over the next few years. Once growth is estimated, analysts often adjust valuation ratios such as the price to earnings ratio in an ad hoc manner according to these earnings growth estimates. Finally, valuation analyses that are derived from long-term cash flow projections implicitly or explicitly rely on some growth rate projection – growth in traffic, productivity, demand, real price or some other factor. To properly value investments in all of the three circumstances, growth rate projections by necessity must often be made for a period of two or three decades.

Not surprisingly, prognostication of future growth is a notoriously difficult part of valuation, despite the simple rules used my many analysts. The tendency of investment analysts to be optimistic in their projection of earnings per share growth is a lively subject in finance65 and there are many studies documenting the upward bias of equity analysts who surprisingly do not seem to evaluate their forecasts after the fact.66 In contrast to the equity analysts, investment bankers who perform discounted cash flow analysis generally make a surprisingly pessimistic assumption that growth in cash flow once a terminal period occurs will be limited to the projected rate of inflation. The valuations depend on the assumption that companies will somehow "stabilize" to a tranquil zero real growth rate in a period of somewhere between five and ten years, perhaps after a smooth transition period until the supposed tranquility is obtained. While the assumption is commonly made, it is difficult to come up with any company -- or person for that matter -- that has reached this kind of tranquil nirvana or has managed such a

[65] McKinsey and Chan from testimony
[66] Black Swan Reference

transition to equilibrium. Further, the valuation analysts do not seem to be concerned about the basic point that if all companies somehow reach this kind of equilibrium where there is no real growth in cash flow, no companies would contribute to real economic growth and the world economy would stagnate in a never-ending recession. An illustration of the type of growth rate assumptions made in classic DCF analyses is shown in the graph below.67 Of course, the date at which the transition from short-term to long-term growth occurs and the length of the transition period is arbitrary.

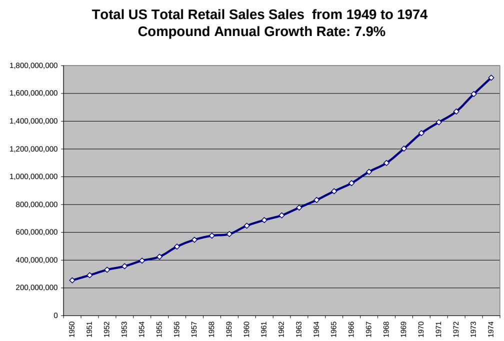


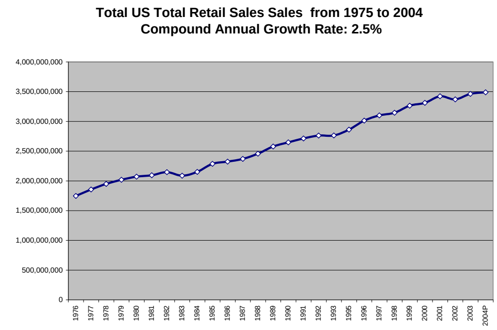
While questionable logic (such as assuming world economic growth will stop) and errors in the prediction of growth are pervasive in valuation, the errors in valuation analysis discussed here are not related to under-estimating or over-estimating growth. Precisely because the exercise of predicting growth is so difficult, it would be presumptuous to assert that valuation analyses were flawed when someone made an optimistic or pessimistic estimate – growth rate uncertainty is a big part of the reason that cash flows themselves are uncertain. Instead, the analytical mistakes described here are related to appropriately accounting for the fact that one cannot precisely determine when the growth rate in a company or an industry will begin to moderate. Given the inherent uncertainty of guessing at what date growth rates will change, investments that can more easily respond to changes in growth rates or are less sensitive to growth rate variation should be valued more highly than investment strategies which cannot easily adjust to changes in growth. Valuation errors occur when the value of this flexibility to adjust to changes in growth rate is ignored.

[67] Growth rate in the transition period can be constructed from the equation: $g_t=g_{t-1}$ x[1/(short-term growth/long-term growth)]^(1/transition period).

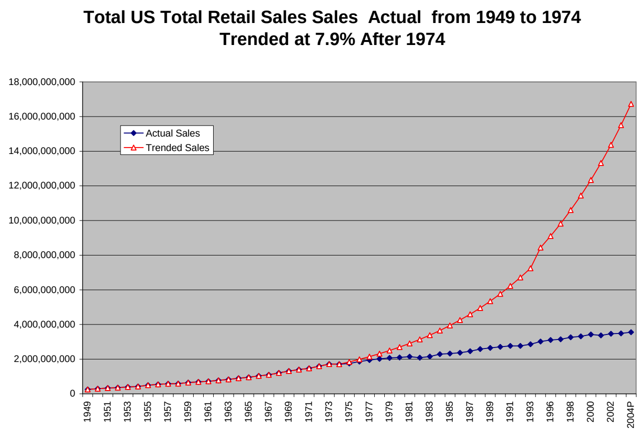
In many industries, delusion that growth rates will continue have led to dramatic valuation errors. For example, in the U.S. sub-prime crisis of 2007-2008 involving home mortgages, the assumption that prices of residential homes would steadily rise resulted in aggressive lending practices. Of course this assumption that housing prices continue to grow could not be sustainable, particularly in light of the increased supply of houses that occurred as a result of the lending practices themselves. Errors in growth projections of housing prices had disastrous effects on bank balance sheets as well as the economy of the whole world. In the electricity generation industry, serious mistakes have been made by not considering how uncertainty in demand growth affects alternative investments. Two situations are presented below in which valuation did not appropriately consider the ability of investments to react to different achieved rates of demand growth. The examples include signing long-term inflexible contracts by distribution companies in the Philippines and the construction of electricity capacity with long lead time in the 1970's and 1980's in the U.S. Mistakes from not properly accounting for risks associated with different potential growth when considering investment possibilities resulted in enormous costs to investors and consumers in both cases.

In the U.S., electric power demand grew at a compound growth rate of 7.9% from 1949 to 1974 and then, in years since, it has grown at a much smaller compound growth rate of 2.5% which is roughly comparable to the level of overall economic growth. The change in growth rate that occurred in the mid-1970's implied that growth did indeed stabilize corresponding to the standard assumption so often made in DCF models (although the growth did not decline to zero corresponding to the typical assumption.) It is tempting to suggest that the change in demand growth rates in the 1970's was predictable – with hindsight it is of course easy to criticize many historic forecasts. The achievement of stable year to year growth above 7% in the 1950's and 1960's naturally led managers to make projections of similar growth rates for subsequent periods. Using historic data, a trend line forecast would surely have outperformed any other multiple regression or complex time series analysis method. As illustrated by the graph on the left below, history of electricity power demand growth did not seem to suggest that growth rates for this industry would stabilize.





While examination of historic trends on the first graph would imply that historic growth will continue, a growth rate of 7% -- which is well above the real growth rate in the economy -- was in fact not sustainable over the long-term for a couple of obvious reasons. First, if demand for a product is projected to grow at rates above the overall real growth rates in economic activity, that product would eventually become the whole economy (if electricity grew at 7% and the rest of the economy would grow at 2%, electricity would be the only product in the economy in thirty years.) Second, high growth rates are very difficult to sustain for long periods simply because of the fact that the business becomes large and growth rates from a low base are much easier to achieve than growth rates from a high base. Because there was no historic evidence of a growth rate other than 7%, only by using judgment and not relying on historic data could the growth rate decline have been predicted. Had the trends in growth rates from the earlier 1949-1974 period been used to project future growth, the errors in demand projection would have been enormous and the errors would have grown with longer projection periods as shown in the graph below. The red line shows growth that would have occurred if historic trends had continued while the lower blue line shows the actual demand.



Given the history of demand growth, electricity companies in the 1970's decided to build many coal and nuclear plants with long construction lead times since these plants were though to be far more valuable than investments with shorter construction periods such as oil and natural gas plants, particularly after the oil price shocks of 1973 and 1979. Oil and natural gas prices were rising and larger plants were thought to have significant economies of scale. When growth did not materialize, many large plants that were in the midst of being constructed were not cancelled (managers ignored the value of the option to cancel because of psychological attachment to investments) and massive surplus capacity remained in the market for more than a decade. The surplus capacity led to contentious price increases for consumers as well as billions of dollars of write-offs associated with surplus capacity that accrued to shareholders. The problem of building investments that could not adjust when demand change lasted into the 1990's until demand growth finally caught up with supply. With hindsight it is apparent that managers should have employed more flexible strategies through construction of a portfolio that included smaller plants with less construction lead time that could have responded to changes in demand – even if these plants had a lower value in the base case scenarios which projected continued high growth. While this value of flexibility and risk analysis of alternative growth seems obvious with hindsight, most valuation analyses in the 1970's concentrated on a base case scenario and the amount of time and analysis spent seriously studying exposure to factors such as changing growth rates was limited. It is tempting to fault analysts in the industry for not predicting the date at which the change in demand growth occurred. The real problem is not performing risk analysis that considers the possibility of changes in demand growth when comparing investment alternatives.

The Philippines has experienced similar problems to those discussed above where investments are premised on sustaining high levels of demand growth. In this case the problems arose from signing long-term take or pay contacts to

purchase power which could not be adjusted in the case of lower than expected demand growth. During the 1980's demand growth in the country had been strong [TRY TO FIND DATA] and the Bantam nuclear station (two 600 MW units) commissioned to meet the demand could not begin operation. From 1989 to 1993 power shortages resulting from increased demand and problems with the nuclear plant caused brownouts of 4-8 hours per day in Manila and resulted in large economic losses estimated at 1.5% of GDP.68 In response to the power shortages, state-owned and private distribution utility companies signed long-term contracts with 35 independent power generators to construct new capacity of 8,425 MW relative to demand of about 4,000 MW. Needless to say, the value of the contracts depended on realization of a lot of growth.69

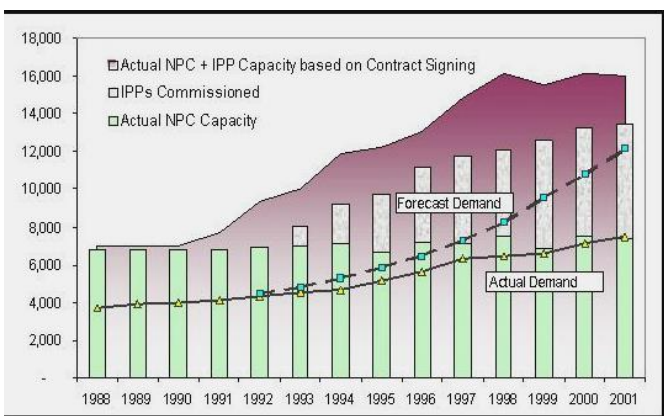
When the long-term contracts, known as Purchased Power Agreements (Papas), were established, it seemed that simply by signing contracts, the Philippine power shortage could be alleviated and better yet, the Philippines government would not even have to borrow money to rectify the problem. From the perspective of private developers, who agreed to construct capacity under the contracts, the focus was on obtaining attractive equity returns through raising high levels of debt and securing political risk insurance. On the other hand, policy makers likely emphasized the costs of not having sufficient capacity to meet load rather than the risks associated with uncertainty in demand growth. After the fact it is clear that instead of exclusively locking into long-term contracts, power should have been secured through waiting for growth to materialize and then either signing short-term contracts or contracts for less expensive peaking capacity.

Distortions in evaluation of the risk from the manner in which plants were financed is illustrated by the case of a 123 MW bunker fuel power plant named Subic which developed by Enron Corporation at a cost of $142 million or $1,157 per kW (more than double the cost of combined cycle natural gas plants built in Western Europe and the U.S. at the time). The plant was able to achieve a high level of debt financing because it signed a 15-year contract with the state owned distribution company NAPCOR that included a capacity charge of $260/kW/year (more than four times the $60/kW/year carrying charge estimated used for peaking capacity in the U.S. at the time.) From the perspective of Enron, the risk of uncertainty in demand growth was not relevant since a power contract assured revenues. The relatively low risks of cash flow were demonstrated by the fact that the plant was able to obtain 72% debt financing (even though it did incur a relatively high credit spread of 3.85%.) Private financing of the plants was

[68] Report of Philippines Department of Department of Energy,
[69] Secretary Vincent S. Pérez, Jr., Department of Energy, 06 September 2002

possible as long as multi-year contracts with no flexibility that transferred risk away from developers such as Enron.

The Enron contract and the other contracts were signed in anticipation of increased demand growth. When the contracts were signed, the aggregate national demand was about 4,000 MW. However demand growth did not materialize, in part because of the higher prices caused by the contracts themselves. As shown in the graph below, demand was projected to grow by 10% per year and hit almost 12,000 MW by 2001, whereas actual demand grew at only 2% and reached 6,000 MW. Because of the long-term contracts, capacity reached about 16,000 MW in 1999 implying a reserve margin – surplus capacity divided by load -- of 167% (a 15% to 20% reserve margin is considered adequate in the U.S. industry.) Since the contracts included fixed obligations that had to be paid no matter what the overall demand was, they created enormous financial distress for the state owned utility company and they caused a general mess of the whole economy of the Philippines. For example, settlement of the power contracts and bailout of the distribution company is estimated to have cost $14 billion due in part because of devaluation of the Philippine peso which increased power purchase cost 170 billion pesos to 240 billion pesos.70 Because of the power contracts, residential power rates more than doubled and industrial rates are the highest in Asia.71



The lesson of the Philippines and the U.S. cases is that valuation analyses of investments should explicitly consider the ability of economic investments or

[70] Philippine Center for Investigation, 5-8 August 2002. Trail of Power Mess Leads to Ramos, Kuz Rinbon and Shelia Sumonte-Pesayco.
[71] Alecks Pabico, Short-circuited Reforms in the Power Sector, 16 November 2007.

contracts to respond to uncertainty in economic variables – particularly the uncertainty in growth rates. In both situations there seemed to be little recognition given for the possibility that historic growth would not be a good predictor of future growth. With hindsight it is clear that the manner in which the investments respond to unpredictable growth should have been a central parameter in assessing the value of investments. Traditional financial theory would suggest that somehow the weighted average cost of capital should be increased for the investments which have less flexibility with respect to growth and therefore higher uncertainty. Modern theory may frame the issue of flexibility with respect to demand growth as a real option and assign a premium to the investment strategies that are more flexible. In practice, even if one could come up with reasonable methods to derive the cost of capital or the option premiums, it would be very difficult to explain these risk adjustments in a convincing manner to management.

Rather than measuring risk of different investment alternatives by attempting to quantify the discount rate associated with specific investments, a more risk analysis process could surely be developed which directly simulates alternative demand growth possibilities. In developing such an analysis, the cost of experiencing higher electricity outages would have to be gauged against the cost of paying for surplus capacity that is not needed to meet demand. Once a range of demand growth scenarios would be obtained, the value of the strategy with no flexibility could be compared to the value of a flexible strategy. In the U.S. case, the flexible strategy would involve plants with higher expected cost and shorter lead times while in the case of the Philippines, the flexible alternative may have been to consider quickly building additions to existing plants without the long process of project financing. The value of the flexible strategy would be compared to the value of the less flexible strategy under a range of different growth rates. Because of the ability to not commit to capacity long before demand growth is realized, the distribution of value of the in-flexible alternatives would have been wider than the distribution of value of the inflexible alternatives.

With hindsight, decision making in the two cases discussed above would have been improved through performing risk analysis with respect to different growth rates. While the inflexible long-lead time investments or the PPA agreements may have looked more valuable with higher growth, risk analysis would illustrate an alternative outcome. When thinking about what it means to perform risk analysis or to be a risk manager, one may imagine a person working on value at risk quantification using volatility statistics and complicated mathematical models. However if one were to construct a risk analysis process to assess the value of flexible investments with respect to growth, it is probably more effective to begin with far simpler techniques. First, you could begin by simply

developing a sensitivity analysis that graphically presents the value of the flexible (e.g. short-lead time strategy) and the inflexible alternative (long lead-time strategy) with different growth rates. Next, you could find the break-even growth rate before which the flexible alternative becomes less valuable than the inflexible alternative. Through assessing the probability of the achieving various growth rates you consider potential variation in the growth rate along with other variables such as the oil price, inflation rates, interest rates etc. The scenario analysis could measure the relative value of upside cases, downside cases and other possible combinations of assumptions so that you could determine which combination makes the flexible alternative more or less valuable than the other. Since the scenario analysis does not tell you which variable has the largest effect on relative value, a tornado diagram could be presented that ranks the impact of variables on the relative value of the different alternatives from the highest to the lowest and then presents the impact of the changes in value from a downside case to an upside case on a graph. Finally, you could come up with a mathematical equation for demand that accounts for the variability in demand over time and then develop a Monte Carlo simulation. This would provide you with an explicit probability distribution of the relative value of the two investments and you could directly see both the risks and the costs of the two strategies.

It is tempting to suggest that the Monte Carlo simulation approach is the best way to evaluate risk, but in realistically assessing risks, the most useful tools are probably in the same order as the above list. The most useful techniques are the sensitivity analysis and the break-even analysis while the Monte Carlo analysis provides a nice way to demonstrate that you have performed sophisticated analysis. Chapter 3 includes a discussion of how to implement and analyze the different risk analysis techniques. Chapter 2 describes how to build financial models that form the basis for risk analysis.

Case 8 – Understanding Upside and Downside Risk in Scenario Analysis, the California Electricity Crisis Case

Synopsis of the Case

The next case addresses the power crisis in the U.S. state of California during from about May 2000 until May 2001 from the perspective of scenario forecasting and appropriate development of downside cases. During the period of the crisis, prices of electricity skyrocketed, there were numerous power outages and one of the largest and oldest utility companies in the U.S. – Pacific Gas and Electric -- declared bankruptcy. The crisis led to fierce debates between advocates of free markets in electricity versus supporters of regulated rates. Some asserted that the primary cause of the crisis was extraordinary supply and demand conditions while others suggested the cause was aggressive market manipulation by companies located outside of California, mainly in Texas. Discussions of the California power crisis continue to be influenced by vested interests of the party making the commentary -- advocates of free market argue the power crisis was driven by natural forces and bad implementation of deregulation; opponents of deregulation argue that the crisis shows how open markets cannot work in electricity; supporters of the utility companies complain about the manner in which contracts were mandated; and representatives of energy suppliers insist that market manipulation was not a major factor in the crisis. No matter what was the root cause of the crisis, there is no question that the situation in California put a stop to the deregulation movement around the whole world. It is also clear that very sophisticated analysts who developed the California market had not predicted the possibility of the price spikes in their risk analysis even though the fundamental factors that supposedly caused the crisis including demand growth, low water flow, plant outages and fuel price volatility were entirely predictable from historic data. Experts who developed pricing models could not predict the possibility of extreme scenarios outside of relatively narrow ranges. Nobody was

able to predict the dramatic difference in prices that result from situations with surplus supply and circumstances with constrained supply. Various forms of power emergencies and power outages that resulted from the California crisis and the stock price of the parent companies of the three utility companies are shown on the two graphs below.

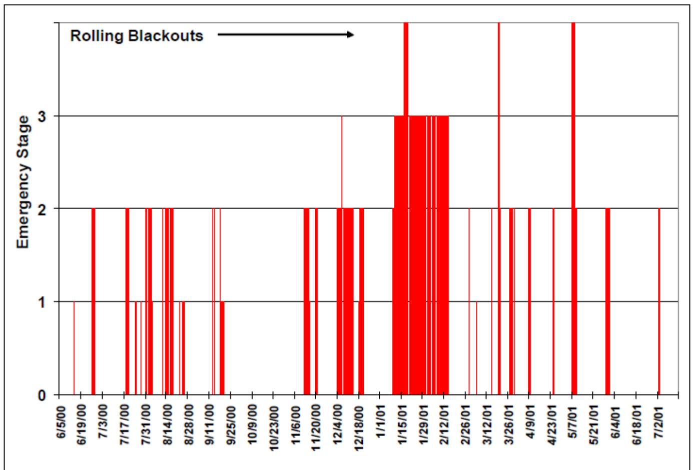
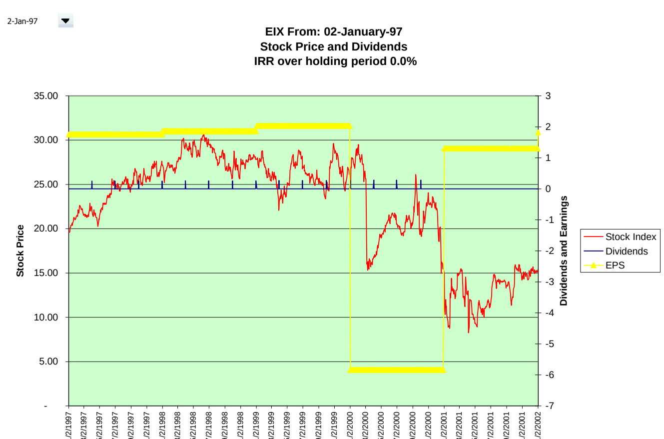


Figure 32 Energy Emergencies and Blackouts in California



The typical process used in financial analysis when developing projections is to spend a lot of time developing equations in a model and concentrating on the base case assumptions. After the base case is developed, alternative downside and upside scenarios are created that sometimes simply increase and decrease assumptions by factors such as 20% relative to the base case. Carefully thinking about assumptions for alternative cases that consider relationships which can be complicated is often almost an after-thought. In the case of the California crisis,

development of ranges in the level of demand, hydro production, plant outages, new capacity development and gas prices could be obtained from vast databases of historic data, published capacity expansion plans and futures markets. Indeed, construction of market price models from these factors was and is quite standard in making forecasts and the actual outcome of variables was certainly not a "perfect storm" which is often used by advocates who suggest market power and game playing was not prevalent. However, combining the objective variables such as demand growth with judgment as to what could happened with potential exercise of market power and contemplating the secondary effects was apparently not part of the process. The measurement of risk is driven more by assessment of what happens in a downside case than betas and standard deviation of cash flow. The downside case may exhibit type of non-linear relationship that caused such large mistakes in policy implementation and in the financial condition of public utility companies that were forced to buy power in de-regulated markets. Risks the analysis of wholesale prices is discussed by Sweeney:72

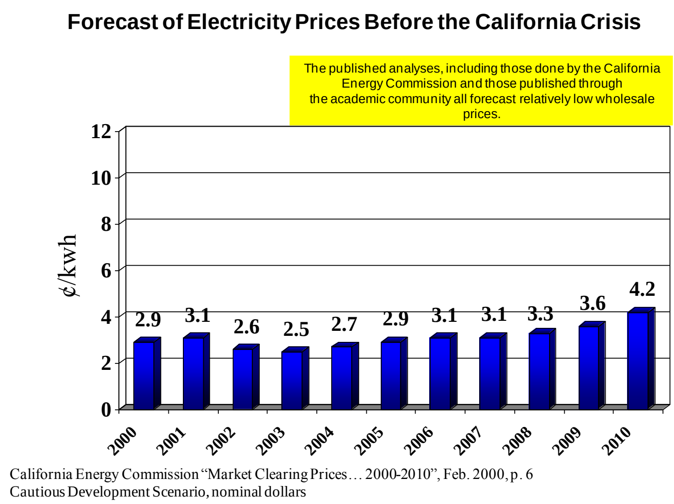
"High wholesale prices turned out to be a very large risk. But the risk may have been severely underestimated or completely unrecognized by many participants in the process. The utilities could have protected themselves against high wholesale price by entering contracts for financial hedges, designed to cover risks of buying power from a volatile spot market while selling it at a frozen retail rate. However, although such hedge contracts were offered to utilities, they rejected these offers, apparently believing that the hedges included overestimates of the risks and thus that the prices of the hedges were too high."

The risk to utility companies was aggravated because of the structure of the market which was often the major complaint of economists who favor free markets (and who were often paid consultants of participants in the process). The structure of the market had fixed the prices for the three large California utilities – Pacific Gas and Electric, Southern California Edison and San Diego Gas and Electric – and forced them to divest most of their generating capacity while not allowing them to sign long-term contracts to mitigate the risk of power price movements. The structure of the market also allowed an implicit free option to consumers whereby the retail rates of the utility were fixed, but consumers could shop for power if the price was below the utility option. Prior to the crisis, utilities had a fuel adjustment clause that allowed changes in the price of securing power to passed directly on to consumers. In evaluating the risk this situation, one does not need a complex option pricing model; instead, one can develop a downside case and evaluate the safety margin.

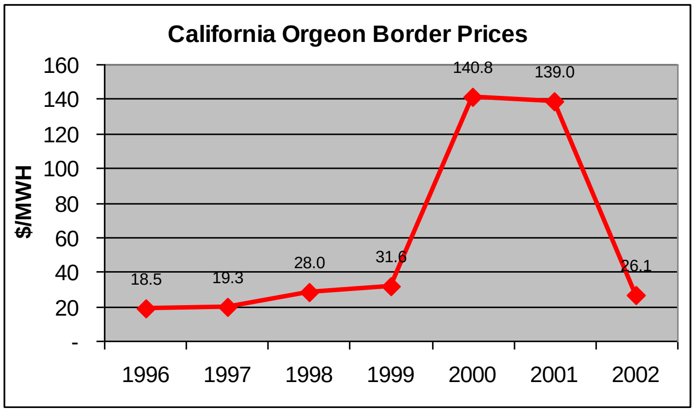
[72] Sweeny,

Volatility in prices versus costs. Utility companies were subject to marginal pricing.

Problem was that risks were skewed. Prices forecast by various entities were relatively stable and typical of price forecasts made in other market areas that were being de-regulated. The graph below shows a forecast made by the California Energy Commission which predicted annual prices in 2000 of US$29/MWH and prices in 2001 of US$ 31/MWH. Actual prices shown in the subsequent graph demonstrate that actual prices in 2000 were US$140/MWH and US$ 139/MWH in 2001. When making price forecasts it was typical to expect occasional price spikes, but these spikes were very short-lived as electricity prices had an extreme mean reverting pattern. (Forecasts made by the purchasers of older efficient plants who paid relatively prices had to assume many price spikes in order to justify their price, but these implicit price forecasts were ignored.)



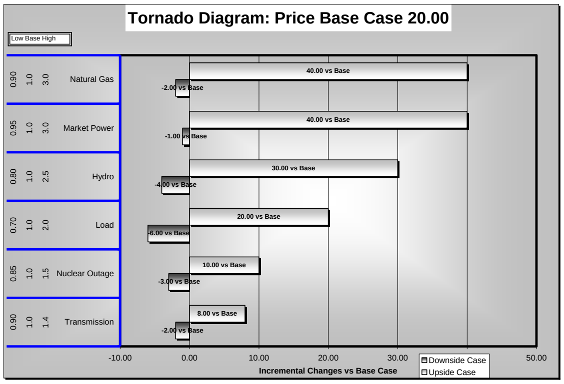
Actual prices were dramatically different as shown in the graph below. When evaluating the factors that cause prices to be volatile – the demand changes, the hydro variability, the outage probability and the fuel price volatility. Each of these factors did change, but nothing was extraordinarily out of the norm.

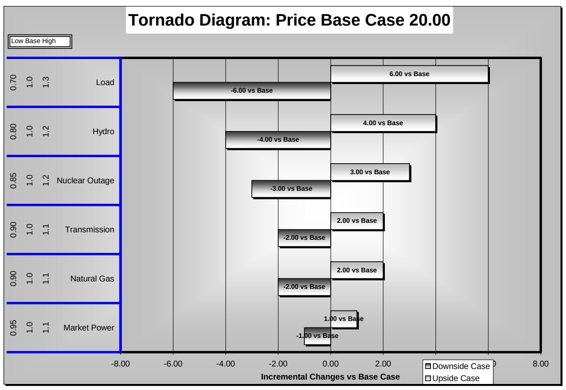


In developing ranges of price forecasts that underlie cash flow forecasts, valuation analyses are often clustered in a narrow range rather than accounting for the full dispersion in possible prices, volumes, and costs. Further, forecasts tend to be upwardly biased and clustered in a narrow range rather than accept the probability of prices falling to a lower boundary. The credit rating agency Standard and Poor's states that " ." For capital intensive assets, prices can fall to short-run marginal cost when surplus capacity exists in a market and in some cases this contingency should be considered in valuation.

Problem with historic data. First error made by not evaluating history and somehow assuming that history will not repeat.

In developing cash flow projections that underlie valuation analyses, the potential upside is often assumed to be equal to the downside and linear extrapolations are made from historic data. A lot of time is typically spent on a base case forecast and then the downside and upside cases are relatively simple adjustments to the forecast. Contrary to these typical methods, real world data often does not have a symmetric distribution and relationships are sometimes relationships between variables are highly non-linear. If the downside does not equal the upside and/or if cash flow distributions are skewed, then the valuation analyses will be wrong. I





A well known problem with valuations using discounted cash flow is that many distributions do not have symmetric distributions. The reason real call options to cancel, expand, retire, and operate a plant have value is that the options limit the downside potential of the cash flows. These real options imply that the discounted cash flow model understates the true value of assets to some degree. The magnitude of the error caused by neglecting real options depends on how the option affects the skew ness of cash flows. This skweness in turn is driven by the volatility in the cash flows and the ability of management to make decisions influences the cash flows.

Real options do not necessarily increase the value of an asset if the options can be exercised by customers or government policy makers. Here the option limits the upside potential of the cash flow and it increases the downside exposure. Neglecting to consider the downside exposure can result in valuation errors. Such was the case associated in California. In negotiating provisions for de-regulation, California utility companies agreed to cap their prices to customers and pay prices for power that were subject to fluctuations and were not similarly capped. The agreement allowed the utility companies to recover the cost of previous inefficient decisions from customers. This policy effectively created a call option for customers limiting their downside exposure to high power prices in return for

making payments for the prior inefficient decisions. It also created a put option for the utility companies exposing them to increases in power prices. When developing the policy it was assumed that prices for purchasing power would remain relatively stable and that prices would only reach high levels for a few hours per year. It was also assumed the markets would operate in an efficient manner without companies exercising market power.

In 2000 and 2001, prices of purchased power increased dramatically as shown on the graph below. The California market had no separate capacity market as with the PJM market, the pre-NETA UK market and the Argentina market. The California market contrasted with other power markets because it has a relatively high reliance on hydro generation and natural gas and the transmission network can become congested.

The above graph demonstrates the dramatic volatility that can arise from a capacity shortage, high fuel prices and low hydro output. There were many reasons for the high prices including demand growth, insufficient capacity additions, transmission bottlenecks, increases in the cost of natural gas, reduced hydro output, nuclear plant outages, exercise of market power, shortages of environmental emission allowances and limited demand response. A lively debate has arisen as to how much of the price protracted price increase was due to cost increases or excess profits earned by suppliers.73 A notable aspect of the annual California prices was that there was little signal in the historic prices themselves that suggested a dramatic rise in prices would occur.

Also discuss Zion and South Africa.

For the utility companies, the realization of high purchased power prices and the inability to pass along the higher prices because of the price cap policy led to the bankruptcy of Pacific Gas and Electric and financial distress of Southern California Edison. The stock price of Edison International – the holding company for Southern California Edison is shown below.

[73] See Robert McCullough, "Price Spike Tsunami: How Market Power Soaked California," *Public Utilities Fortnightly*, January 1, 2001, pp. 22 - 32.

The fundamental lesson is to perform and understand risk analysis – this means examining the underlying variables and attempting to construct implicit or explicit probability distributions of the variables and the interaction of the variables.

The effect of real options on asset value is described in Chapter ___. The chapter describes problems with measuring these options and how to practically apply the techniques in the context of electricity plants.

Discuss correction and appropriate analysis of the distribution of cash flows. Analysis should consider extreme values which often cannot be gauged from historic data and assumption that distributions will follow normal distributions.

When reviewing valuation mistakes such as those made in the Eurotunnel case, one often wonders why seemingly obvious checks on complicated models are often not made. One of the potential answers is simply the desire for bankers, consultants and lawyers for earning fees. With the potential for earning fees, financial analysts seem to be able to make themselves believe stories that would seem ridiculous to others. Nassim Taleb terms this as the firehouse effect which holds that firemen with much downtime who talk to each other for too long come to agree on many things that an outside, impartial observer would find ludicrous (they develop political ideas that are very similar). After changing the business world in the 1980's, leveraged buyouts became more risky. In their text, Koller, … [FIND QUOTE SOURCE] "[w]e have reviewed some financial projections that underpinned several high-profile LBO bankruptcies in the late 1980s. Many of these transactions were based on assumptions that the companies could achieve levels of performance, revenue growth, operating margins, and capital utilization never before achieved in their industry." The authors suggested that the reason investors did not question these "shoddy analyses" was due to fee potential and the tendency for one bank not to question the analysis of other banks: "In many of these transactions, bankers and loan committees felt great pressure to keep up with their peers and generate high up-front fees, so they approved highly questionable loans. In other cases, each participant assumed someone else had carefully done the homework. Buyers assumed that if they could get financing, the deal must be good. High-yield bond investors figured that the commercial bankers providing the senior debt must surely have worked their numbers properly. After all, the bankers selling the bonds had their reputations at stake, and the buyers had some

capital in the game as well. Whatever the assumption, however, the immutable laws of economics and value creation prevailed. Many deals went under."

Results of the aggressive assumptions in terms of the default rate on junk bonds used to finance many of the leveraged buyouts are shown in the graph below. The graph presents the number of defaults divided by all bonds that had a rating of BB+ or lower. From 1981 to 1985, the default rate was around 4%, suggesting that a credit spread of about 4% would have been sufficient to cover risks (the appropriate credit spread is described in detail in Chapter 4.) From 1989 through 1992 the default was much higher, reaching 12% in 1991 which resulted in a dramatic decrease in the number of issuers such as leveraged buyouts.

Conclusion – use economic principles described in Chapter 3 and Chapter 6. Use break-even analysis described in Chapter 3 for complex variables.

The foundation of the case is a write-up titled "First Solar, Inc. in 2010" published by Stanford University[74]. Additional sources of information for the discussion in this chapter are ValueLine reports that illustrate how investment analysts may compute value for a share of stock. The case write-up begins by describing some of the difficulties for solar manufacturers and whether Firstsolar's "well-earned success" could be continued. As with other HBS cases, the Firstsolar case is complementary of management and even includes resumes of key management in an appendix. Additional platitutes mentioned in the case include:

Selected Valuation Nightmares other than the Sub-prime Crisis

The case studies presented below each isolate on one of the single valuation issues associated with the sub-prime crisis and delve into further detail. Reviewing other cases demonstrates that the problems discussed above in the context of the sub-prime crisis are in no way unique. It was simply the larger magnitude that meant errors in home mortgage lending created the financial crisis.

[74] *2010 by the Board of Trustees of the Leland Stanford Junior University.*

Cases discussed include the merchant power meltdown of 2002-2003, the over-leveraging of the Eurotunnel project, excess capacity from nuclear plant construction in the 1970's, the meltdown on debt and equity values for Telecommunications companies, Enron's failure with its Dabhol plant in India, and financial fallout from the California electric power crisis. As with the sub-prime crisis, these situations also involved a toxic mixture of the valuation problems. One could easily come up with examples of dramatic mistakes in valuation have occurred in many other sectors. For example, other than real estate mortgage loans in the U.S., if one were to study the crash of many telecommunications companies in 2000 and 2001, bursting of the internet bubble, the demise of Long-term Capital management in the late 1990's, the failed merger between Chrysler and Mercedes Benz, investments made before the East Asia Crisis of 1997 and many other cases. Below the headlines of these financial disasters were very similar underlying mistakes as those which are discussed below.

Each of the valuation nightmares had effects not only on investors in the investments, but also on the general public. In the case of mis-estimating the cost of capital through not correctly estimating the debt capacity, over-investment or under-investment results in mis-allocation of resources that have important macroeconomic effects. In other cases, ignoring the mean reversion in prices leads in aggravating cyclicality, leading to higher volatility in prices. Finally, in many situations, consumers face higher prices or taxes to rescue the investment mistakes. In yet other cases, the mis-estimation of upside versus downside has caused power outages. Those involved in the valuations often use the term perfect storm to imply that a series of very unlikely events that could not have been reasonably predicted happened at once. This term is inappropriate and irritating once one studies the different valuation mistakes. With hindsight, most of the valuation errors were not the result of completely unpredictable events, but rather could have been foreseen with a bit of very basic economic analysis.

The case histories selected to introduce valuation issues analysis include a similar basket or mistakes as those introduced above for the subprime crisis. The cases involve one or more of the following errors:

Assuming that prices and volumes can continue to increase in tandem in the presence of surplus capacity.

Relying on experts for forecasts and valuation who do not have a financial interest in investments without verifying analysis with back of the envelope analysis.

Using statistical analysis on historic data without realizing the manner in which economic variables can suddenly change in non-linear ways.

Ignoring differences in the flexibility of alternative investments in how they react to key economic variables.

Believing in innovative valuation techniques that suggest easy money can be made without understanding the ultimate source of cash flow.

Not studying long-term marginal cost relative to prices in evaluating cash flows.

Making simplistic assumptions with respect to downside and upside cases rather than recognizing differences in upside potential and downside risk.

Assuming that contracts will protect investments without delving into the potential for contracts to be broken or mismatched.

Before considering the valuation problems, it is worth noting factors that were not very important in making the mistakes. The mistakes in valuation did not generally arise from many of the factors discussed by in the theory of finance. Pablo Fernandez published an article with a seductive title -- “110 Common Errors in Company Valuation.” He discusses how errors arise from factors such as incorrectly measuring beta, wrongly computing the tax shield on debt, and including operating as well as surplus cash in the valuation.75 It is doubtful that any of the flawed investment decisions described below would have been solved by more accurately estimating beta or the weighted average cost of capital or more accurately separating surplus cash from operating cash.

Further, the financial crisis should have prompted analysts to cease blind adherence to financial theories and models that do not work. But since 2008, the underlying theory has not changed much.

Long-term marginal cost in the real estate industry can be gauged by the cost of building a new home. Short-term marginal cost is much less. In areas with a lot of vacant homes, the price could fall to very low levels that reflect not much more than land values. This happened in some markets such as the City of Detroit where vacant homes were simply torn down. The graph of median housing prices in the U.S. shown in Figure 2.2 demonstrates how housing prices dramatically increased at the turn of the century and then fell to levels consistent with long-term trends and inflation. The lesson that prices can crash in capital intensive industries with surplus capacity was learned the hard way.

[75] Pablo Fernandez, “110 Common Errors in Company Valuation”, Working Paper, November, 2007.

Valuation Errors Addressed in Case Studies

When discussing these cases histories, analytical errors made at the time of the investment are summarized at the beginning of the case. Some of the prominent valuation errors include: (1) the assumptions that prices and margins can somehow increase when there is increasing supply and surplus capacity in a market; (2) the failure to check complicated opaque models with simple tests or metrics such as evaluating project IRR and return on invested capital (ROIC); (3) the adoption of complicated analysis made by others without adequate independent analysis and back-of-the-envelope checks; (4) belief in supposedly innovative new valuation techniques such as real options models that focus on other things than future cash flows and their risk; (5) ignoring the underlying marginal cost drivers of prices in deriving assumptions for revenue forecasts; (6) applying multiples such as the P/E ratio or the EV/EBITDA ratio without evaluating underlying fundamentals of the company being valued such and how much ability it has to earn returns above its cost of capital in the long-run; (7) failure to understand non-linear upsides and downsides of many investments when assessing risk and misapplying stochastic analysis; (8) not paying attention to the benefits of flexibility in assets and the costs of inflexibility; and (9) application of statistical approaches that assume historic trends and volatility in key variables will continue.

The bond financing originally was planned to be US$650 million, but it was later raised to US$1 billion after indications of investor interest. The commercial loan portion of the financing was scaled back proportionally. Because of favorable response in bond market, raised more than expected from banks and used $450 million in bank debt.

Bonds purchased by investment advisors, insurance companies, mutual funds, pension funds and individuals.

was arguably a breakthrough in project finance. It was financed in ___ as a joint venture between Conoco and PDVSA. The project was structured and financed a few years before Hugo Chavez came to power. To be sure, there are valuable project finance structuring lessons in the case. Particularly because without project finance, project would not have been built or would not be feasible because of a high cost of capital. Proud to pierce the sovereign veil. Built the project when the price of oil was very low. Good reference for the oil price is pink data from the World Bank. People become very emotional about this and suggest that the Country of Venezuela made a big mistake. This is not the subject here.

Included risk allocation matrix for lenders where risks were mitigated by construction support.

The costs of fracking should also be included in the analysis. If the shale gas can be produced for less than $50 per barrel, making loans to companies and equity investments may be a reasonable proposition, “The very high decline rates of shale gas wells require continuous inputs of capital—estimated at $42 billion per year to drill more than 7,000 wells—in order to maintain production. In comparison, the value of shale gas produced in 2012 was just $32.5 billion.” If the shale gas can produce only for one year, the investment cost is more than the production. Petrozuata was assigned an area of 300 square kilometres (km) for the production of extra-heavy crude oil by the Venezuelan Ministry of Energy and Mines. The assigned area is estimated to carry approximately 21.5 billion barrels of original oil in place. If the production costs including capital costs are much higher, then the risks and the overall economic benefits of shale gas are more questionable. In evaluating risks of commodity projects in general this should be a starting point of the analysis. For shale gas and shale oil projects, the underlying cost of production is a controversial issue. The graphs below show the cost estimated for natural gas for various projects. This is a difficult issue because of the question of how much drilling and fracking must occur to get a barrel of oil out of the ground. Cost of production is a central issue Neither the HBS case nor the article by Ben Esty discusses the project IRR, the Equity IRR or the net present value of the project.